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ABSTRACT

This curriculum guide provides an outline for an eight-unit course to train automobile air conditioning and electrical system technicians. Each unit focuses on a duty that is composed of a number of performance objectives. For each objective, these materials are provided: a task, a standard of performance of task, source of standard, conditions for performance of task, enabling objectives, resource list, teaching activities, a criterion-referenced measure and answer key, and a checklist for the performance objective, which is really a performance test. A total of 180 performance objectives are covered in these eight units: auto heating, cooling, and air conditioning system diagnosis; maintaining and repairing automobile air conditioning systems; maintaining and repairing automobile cooling and heating systems; maintaining and repairing air conditioning and heating control units; diagnosing the automobile electrical systems; maintaining and repairing automobile electrical accessories; and conducting shop operations. Appendixes include a cross-reference table of duties, tasks, and performance objectives; definition of terms; tools/equipment/work aids; state-of-the-art literature; bibliography; and source of standard. (YLB)

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ED298305

V-TECS GUIDE

FOR

AUTOMOBILE AIR-CONDITIONING

AND

ELECTRICAL SYSTEM TECHNICIAN

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ACKNOWLEDGMENTS

The Automobile Air Conditioning and Electrical System Technician V-TECS Guide was developed from the Automobile Air Conditioning and Electrical System Technician V-TECS Catalog by a committee of Automobile Mechanic instructors in South Carolina. These instructors are to be commended for their expertise in the field and for their ability to complete the tedious work required in developing this V-TECS Guide. The writers are:

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Upon completion of the writing of Automobile Air-Conditioning and Electrical System Technician V-TECS Guide, six educators and seven incumbent workers were selected to field review the material for validity and reliability. These individuals are to be commended for their thoroughness in providing their expertise in modifying and approving this guide for classroom use. The field reviewers are:

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INTRODUCTION

V-TECS guides are an extension or continuation of the V-TECS catalogs. While the V-TECS catalog is a composition of duties, tasks, performance objectives, and performance guides, it deals only with the psychomotor aspect of an occupation. It deals only with the identification of the "hands on" aspect of the occupation. It does not take into consideration such things as the background information surrounding a task, how to make inferences, generalizations and decisions from a body of knowledge, nor does it deal with attitudes, job seeking skills, safety or energy conservation practices. V-TECS guides take these aspects of teaching and learning into consideration.

Experience has shown that the art of learning can also be taught while teaching subject matter. People need to learn how to learn. V-TECS guides take into consideration how students learn and are an efficient way for instructors to assist them to learn.

V-TECS guides are centered around all three domains of learning: psychomotor, cognitive, and affective. The following is a brief explanation of each.

Psychomotor

Any manipulative skill such as tightening a nut, replacing a hubcap, sharpening a pencil, machining a key slot in a steel shaft, or replacing a SCR in a solid state control panel are examples of manipulative or psychomotor skills. Tasks such as these are identified in V-TECS catalogs. V-TECS catalogs also group tasks by duties and objectives. Each performance objective has a performance standard which must be met to prove student proficiency in the manipulative aspect of the task. The V-TECS catalog, however, does not include any suggestions as to how to learn to do these tasks.

V-TECS guides are developed around psychomotor tasks which are worker oriented.

Cognitive

To perform psychomotor tasks, students must think. To tighten a nut they must know which way to turn it and when to stop turning it so that they won't strip the threads or shear the bolt off. If replacing a hubcap, there is a certain technique that may vary from one to another. For example, start the hubcap by placing the cap in a tilted position and tapping it all the way around until it is properly seated. On a different model, it may be necessary to position the hubcap and snap it all at once. At any rate, students must think about what is being done. This is cognition or a mental activity. Cognition is what goes on in the mind about any job being done. V-TECS guides provide both the collateral knowledge and the impetus to apply cognition to psychomotor tasks.

Students gain cognition through both real and vicarious experiences. They may read, view tapes, memorize or practice a process or procedure until they are certain of it. To test their knowledge, students may be required to decide the proper procedure, method or sequence for performance. This decision making process or cognitive activity provided the basis for higher thinking skills.

Cognition, then, is that process by which information is stored and used. That voice that warns one of potential dangers is cognition. Anything that goes on in the mind is cognition. Students may become the best workers in their jobs; but if they fail to think a process through and apply their experience, they may become just one more statistic. It is cognition that tells them to lock and tag out the power supply to an electrical apparatus before starting to repair it. However, cognition does not apply only to safety. Good cognition or thinking can help employees do a job better and quicker. V-TECS guides provide for the cognition aspects of learning.

Affective

Curriculum writers, supervisors, and instructors often fail to assist students in acquiring a positive attitude toward themselves, their jobs, their school, or their fellow students. V-TECS guides seek to provide assistance to the instructor in achieving this. It is difficult for the instructor to identify little bits and pieces of desirable behavior for every unit and often harder yet to teach them. In this area, students might be judged as to how well they clean up their work area, whether they show up to do the job on time, or whether they must be told several times to do something. Potential employers are interested in student attitude because persons angry at themselves or uncertain of themselves are often poor workers.

A student's ability to succeed on the first job and every job thereafter depends largely on attitude. If, for example, students have the attitude of "let someone else do it," they could be in trouble. Students using V-TECS guides will have activities dealing with how to get along with other students, supervisors, or staff members both in large and small groups.

USE OF V-TECS GUIDE

The guide is designed to provide job-relevant tasks, performance objectives, performance guides, resources, learning activities, evaluation standards and achievement testing in selected occupations.

A V-TECS guide is designed to be used with any teaching methods you may choose. If a lecture/demonstration method is best for you, you will find sufficient help to meet your needs. If you prefer to use discussions or other methods that require student participation, you will find ample help. Regardless of which method is successful for you, a V-TECS guide can save preparation time and offer innovative methods and procedures. For example, students may work either alone or in teams while in class and learn skills in direct relation to what is actually done on the job. This work also takes into consideration student attitudes, thinking skills, and mathematical reading skills.

The use of small groups in teaching can be helpful in two ways: (1) many students may feel inadequate due to their lack of background information in mechanical things; and (2) some students may feel that they are physically incompetent or lack the necessary background experiences. A successful program (course) can provide students with a sense of security by reinforcing positive attitudes while improving skill and knowledge of the subject. By allowing students to interact on a personal level, this task/learner-centered approach can achieve this. As students gain confidence and discover that they are an essential part of a team engaged in the learning-teaching process, their confidence increases. Too, the student in this setting can learn to work without direct supervision. In addition, use of the small-group method permits the instructor to vary instructional routines away from lecture or other full-class methods to activities for single students, pairs of students or any number so desired.

You will find suggestions for specific classroom activities. The activities are not meant to restrict you or your students, but only to suggest a variety of learning activities for each task statement. Please do not feel that you must take your students through all the activities. Although the Guide is comprehensive, teachers will be able to select the content which is applicable to the instructional offering in their schools. Teachers are encouraged to use creativity as they adopt the materials to meet the particular needs of their students.

AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE 01

TASK: Identify causes of engine overheating.

STANDARD OF PERFORMANCE OF TASK:

All potential causes of engine overheating must be checked and all abnormal conditions must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Radiator cap tester
Thermometer
Timing Light

ENABLING OBJECTIVES:

1. Use radiator cap tester.
2. Recognize and identify all parts of a cooling system.
3. Use timing light and thermometer.

RESOURCES:

1. **Cooling System Service**, Filmstrip at ATJE-A.
2. Webster **Auto Mechanics**, pp. 182-191.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook chapter 19 **The Cooling System.**
2. Review and discuss filmstrip **Cooling System Service.**
3. Class will draw a cooling system and identify parts.
4. Demonstrate the steps in The Performance of Task as identified in the Performance Evaluation.
5. Have students complete Performance Evaluation Checklist.

PERFORMANCE OBJECTIVE 01

CRITERION-REFERENCED MEASURE:

Questions

1. Vacuum is prevented in the cooling system by a:
   a. Pressure cap
   b. Recovery system
   c. Thermostat
   d. All of the above.
2. When an engine is cold coolant flows:
   a. Into the bottom of the radiator
   b. Through the heat exchanger
   c. Through the block only
   d. All of the above.
3. Name the types of cooling systems used today.

Answers

1. a
2. c
3. Liquid, air, combination of both

Practical Application:

Identify the causes of engine overheating.

Method of Evaluation:

Use Checklist Performance Objective 01 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 01 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING CAUSES OF ENGINE OVERHEATING

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Checked coolant level.		
2.	Checked coolant for foaming. Caution : Followed manufacturer's procedures in removing radiator cap.		
3.	Checked fan belt condition and tension.		
4.	Checked for vacuum leak at radiator cap or overflow hose.		
5.	Checked for restricted air flow through radiator and/or air conditioner condenser.		
6.	Checked thermostat.		
7.	Checked for excessive head pressure at air conditioning compressor.		
8.	Checked for collapsed lower radiator hose.		
9.	Checked coolant circulation at heater hoses and radiator inlet and outlet by feel.		
10.	Checked for missing or out of place fan shroud.		
11.	Checked gauge and sending unit.		
12.	Checked fluid fan clutch.		
13.	Checked heads and block for internal restrictions.		
14.	Checked ignition timing.		
15.	Checked fuel mixture.		
16.	Identified cause of overheating on work order.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS.

PERFORMANCE OBJECTIVE 02

TASK: Inspect cooling system components for coolant leaks.

STANDARD OF PERFORMANCE OF TASK:

All potential sources of leaks must be inspected and all leaks must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use radiator pressure tester.
2. Recognize all sources of potential leaks.
3. Observe all safety rules

RESOURCES

1. **Cooling System Service,** Filmstrip ATJ5-A.
2. Webster **Auto Mechanics,** pp. 192-197.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook chapter 20 **Auto Mechanics.**
2. Review and discuss filmstrip **Cooling System Service.**
3. Demonstrate steps in task.
4. Have student complete performance evaluation checklist.
5. The student will list the steps in replacing defective parts.

PERFORMANCE OBJECTIVE 02

CRITERION-REFERENCED MEASURE:

Questions

1. Coolant strength can be tested by a:
    a. Pump
    b. Hydrometer
    c. Pressure tester
    d. None of the above.
2. Coolant loss may be caused by a:
    a. Defective cap
    b. Worn pump
    c. Bad hose
    d. All of the above.
3. Overheating can be caused by:
    a. Low coolant level
    b. Loss of coolant flow
    c. Loss of air flow across radiator
    d. All of the above.
4. Poor air flow will be caused by:
    a. Bent or broken radiator fins
    b. Loose fan belt
    c. Fan clutch
    d. All of the above.

Answers

1. b
2. d
3. d
4. d

Practical Application:

Inspect the cooling system components for coolant leaks.

Method of Evaluation:

Use Checklist Performance Objective 02 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 02 EVALUATION

PERFORMANCE TEST FOR INSPECTING THE COOLING SYSTEM COMPONENTS FOR LEAKS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Inspected the entire radiator for wet spots.		
2.	Inspected the water pump for excessive play in shaft and for wetness, indicating a bad bearing or seal.		
3.	Inspected radiator hoses and heater hose for cracks, cuts, hardness, swelling or wetness.		
4.	Inspected thermostat gasket for wetness.		
5.	Inspected radiator cap gasket for adequate seal.		
6.	Inspected expansion plugs in engine water jacket for corrosion and installation according to manufacturer's specifications.		
7.	Checked for signs of water on the engine and transmission oil dipstick.		
8.	Identified source of coolant loss on work order.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE 03

TASK: Identify the source of unusual operating noises.

STANDARD OF PERFORMANCE OF TASK:

All potential causes of unusual operating noises must be checked and abnormal operating conditions must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Stethoscope or sound rod
Belt tension gauge

ENABLING OBJECTIVES:

1. Use stethoscope or sound rod
2. Use belt tension gauge
3. Use standard tool kit

RESOURCES:

1. **Cooling System Service,** Filmstrip ATJ5-A.
2. Webster **Auto Mechanics,** pp. 192-197.

TEACHING ACTIVITIES:

1. Have students read and discuss chapter 20 **Auto Mechanics.**
2. Review and discuss filmstrip **Cooling System Service.**
3. Demonstrate steps in task.
4. Have student complete performance evaluation checklist.
5. The student will list the steps in replacing defective part or parts.

PERFORMANCE OBJECTIVE 03

CRITERION-REFERENCED MEASURE:

Questions

1. A ____________ is the most accurate tool used to diagnose water pump noise.
2. A squealing noise that occurs only when the blower motor is switched on indicates:
   a. Bad A/C compressor
   b. Blower motor defective
   c. Water pump defective
   d. None of the above.
3. Loose belts will cause a ____________ when the engine is accelerated suddenly.

Answers

1. Stethoscope
2. b
3. Squeal

Practical Application:

Identify the source of unusual operating noises.

Method of Evaluation:

Use Checklist Performance Objective 03 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 03 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING THE SOURCE OF UNUSUAL OPERATING NOISES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Listened for water pump bearing noise.	____	____
2.	Listened for belt squeal.	____	____
3.	Inspected blower motor for bearing noise.	____	____
4.	Listened to blower fan for contact with heater housing.	____	____
5.	Listened to air conditioner compressor for noise caused by bearings, reed valves or pistons.	____	____
6.	Identified source of noise on work order.	____	____

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS.

PERFORMANCE OBJECTIVE 04

TASK: Test the air conditioning system for specified output.

STANDARD OF PERFORMANCE OF TASK:

The test must accurately state the achieved output of the air conditioner and any deviation from manufacturer's specifications must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Two thermometers
Table of manufacturer's specifications

ENABLING OBJECTIVES:

1. Use thermometer
2. Use tables listed in manufacturer's specifications
3. Follow safety regulations

RESOURCES:

1. Webster **Auto Mechanics**, pp. 498-504.
2. **Air Conditioning Diagnosis** (Program PTF-9-85-10)

TEACHING ACTIVITIES:

1. Have student read and discuss textbook chapter 50 **Auto Mechanics.**
2. Have students read and discuss brochure **Air Conditioning Diagnosis** (PTF-9-85-10).
3. Have student draw diagram of air conditioning system.
4. Demonstrate steps in the performance of the task.
5. Have students complete Performance Evaluation Checklist.

PERFORMANCE OBJECTIVE 04

CRITERION-REFERENCED MEASURE:

Questions

1. An Air conditioning system absorbs __________ from the air.
2. A loss of refrigerant will __________ air conditioning performance.
3. What is the trade name for R-12?

Answers

1. Heat
2. Reduce
3. Freon

Practical Application:

Test the air conditioning system specified output.

Method of Evaluation:

Use Checklist Performance Objective 04 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 04 EVALUATION

PERFORMANCE TEST FOR TESTING THE AIR CONDITIONING FOR SPECIFIED OUTPUT

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Started engine and turned on air conditioner. Placed one thermometer in the air conditioning outlet vent.	___	___
2.	Placed a second thermometer against the side of the condenser to read the ambient air temperature.	___	___
3.	Compared the readings with manufacturer's specifications.	___	___
4.	Noted any deviation from manufacturer's specifications on work order.	___	___

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS.

PERFORMANCE OBJECTIVE 05

TASK: Test air conditioner charge.

STANDARD OF PERFORMANCE OF TASK:

A high-low pressure ratio outside of manufacturer's specifications must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Manifold gauge set
Manufacturer's Specifications

ENABLING OBJECTIVES:

1. Use manifold gauge set
2. Read and use manufacturer's specifications
3. Follow all safety precautions

RESOURCES:

1. Webster **Auto Mechanics,** pp. 498-504.
2. **Air Conditioning Diagnosis** (PTF-9-85-10) Pages 1-15.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook chapter 50, **Auto Mechanics.**
2. Have students read and discuss brochure **Air Conditioning Diagnosis** (PTF-9-85-10).
3. Demonstrate steps in the performance of the task.
4. Have students complete Performance Evaluation Checklist.
5. Explain safety measures that must be followed.
6. Student will identify cold and hot components of the air conditioning system.

PERFORMANCE OBJECTIVE 05

CRITERION-REFERENCED MEASURE:

Questions

1. Low pressure readings on the gauge set may indicate __________ refrigerant level.
2. A rapid cycling compressor may indicate:
   a. Overcharge of refrigerant
   b. Undercharge of refrigerant
   c. Defective Compressor
   d. None of the above.
3. A very high reading on the gauge may indicate:
   a. System overcharged
   b. Belt is slipping
   c. Defective evaporator
   d. All of the above.

Answers

1. Low
2. b
3. a

Practical Application:

Test air conditioner charge.

Method of Evaluation:

Use Checklist Performance Objective 05 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 05 EVALUATION

PERFORMANCE TEST FOR TESTING AIR CONDITIONING CHARGE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Removed protective caps from high side and low side fittings.	______	______
2.	Attached manifold gauge set to high and low side fittings.	______	______
3.	Started engine and turned on the air conditioner.	______	______
4.	Opened manifold gauge valves.	______	______
5.	Compared gauge readings with manufacturer's specifications.	______	______
6.	Closed valves and stopped engine.	______	______
7.	Removed gauge fittings and replaced protective caps.	______	______
8.	Noted high-low pressure ratio on work order.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS.

PERFORMANCE OBJECTIVE 06

TASK: Test the air conditioning system for refrigerant and oil leaks.

STANDARD OF PERFORMANCE OF TASK:

All oil and freon leaks of air conditioning system must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennslyvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Refrigerant liquid leak detector
Electronic leak detector
Air conditioning charging station

ENABLING OBJECTIVES:

1. Use refrigerant liquid leak detector
2. Use refrigerant electronic leak detector
3. Use air conditioning charging station
4. Observe safety precautions.

RESOURCES:

1. Webster **Auto Mechanics**, chapter 50, pp. 498-504.
2. **Air Conditioning Diagnosis** (PTF-9-85-10) pp. 1-16.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook **Auto Mechanics** pp. 498-504.
2. Have students read and discuss brochure **Air Conditioning Diagnosis** (PTF-9-85-10).
3. Demonstrate steps in the performance of the task.
4. Explain safety measures that must be followed.
5. Have students complete Performance Evaluation Checklist.

PERFORMANCE OBJECTIVE 06

CRITERION-REFERENCED MEASURE:

Questions

1. Wet or oily spots on lines or other parts of the air conditioning system.
   a. Indicates refrigerant leak
   b. Indicates oil leak
   c. Both a and b
   d. Neither a or b.
2. Oily streaks on underside of hood above the compressor indicates the compressor __________ is leaking.
3. Air conditioning component parts are of the _________ pressure type.

Answers

1. c
2. Seal
3. High

Practical Application:

Test the air conditioning system for refrigerant and oil leaks.

Method of Evaluation:

Use Checklist Performance Objective 06 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 06 EVALUATION

PERFORMANCE TEST FOR TESTING AIR CONDITIONING SYSTEM FOR REFRIGERANT AND OIL LEAKS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Connected gauges to fittings on air conditioning system following manufacturer's procedures.	______	______
2.	Added refrigerant to system if no pressure is present.	______	______
3.	Listened for large leaks in system and determined cause.	______	______
4.	Applied liquid leak detector to fittings and areas suspected to be leaking.	______	______
5.	Watched for bubbles forming at any leaking areas.	______	______
6.	Probed components and lines of air conditioning system with electronics leaks detector operating according to test equipment's instructions.	______	______
7.	Looked for oily fittings and connections which will indicate oil leakage problems.	______	______
8.	Noted the location and disposition of observed leaks.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS.

PERFORMANCE OBJECTIVE 07

TASK: Inspect belts and pulleys.

STANDARD OF PERFORMANCE OF TASK:

All cracked, frayed or broken belts must be noted; all loose, bent or broken pulleys must be noted; all abnormal noises pertaining to belts and pulleys system must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Belt dressing
Belt tension gauge

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Use belt dressing.
3. Use belt tension gauge.
4. Follow safety regulations

RESOURCES:

1. Webster, **Auto Mechanics** chapter 50, pp. 498-504.
2. Manufacturer's Repair Manual.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook, **Auto Mechanics**, pp. 498-504.
2. Explain safety measures that must be followed.
3. Have students read manufacturer's recommended procedure in appropriate shop manual.
4. Demonstrate steps in the performance of the task.
5. Have students complete Performance Evaluation Checklist.

PERFORMANCE OBJECTIVE 07

CRITERION-REFERENCED MEASURE:

Questions

1. A belt that is loose should be:
    a. Replaced
    b. Tightened
    c. Ignored
    d. None of the above.
2. Belts that are glazed or oil soaked should be __________.
3. A pulley that wobbles or is noisy should be:
    a. Repaired
    b. Replaced
    c. Good
    d. All of the above.

Answers

1. b
2. Replaced
3. b

Practical Application:

Inspect Belts and Pulleys.

Method of Evaluation:

Use Checklist Performance Objective 07 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 07 EVALUATION

PERFORMANCE TEST FOR INSPECTING BELTS AND PULLEYS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Inspected belts for cracks, glazing, obvious wear, ply separation and grease or oil.		
2. Checked belts for tightness according to manufacturer's specifications.		
3. Checked pulleys for loose bolts, cracks and misalignment.		
4. Operated engine and observed pulleys for wobble indicating loose or bent pulleys, or bent-damaged shafts.		
5. Listened for unusual noises and determined if caused by belts or pulleys.		
6. Quieted any noisy belts by spraying them with belt dressing.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE 08

TASK: Inspect refrigeration components and hoses for restrictions.

STANDARD OF PERFORMANCE OF TASK:

All malfunctions caused by restrictions in refrigeration system must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Air conditioning charging station

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Use air conditioning charging station

RESOURCES:

1. Webster, **Auto Mechanics**, chapter 50, pp. 498-504.
2. Manufacturer's Repair Manual.
3. **Air Conditioning Diagnosis** (PTF-9-85-10), pp. 9-15.

TEACHING ACTIVITIES:

1. Have students read manufacturer's procedure in appropriate shop manual.
2. Demonstrate steps in the performance of the task.
3. Explain safety measures to be followed.
4. Read and discuss **Air Conditioning Diagnosis** (PTF-9-85-10), pp. 9-15.
5. Have students complete Performance Evaluation Checklist.

PERFORMANCE OBJECTIVE 08

CRITERION-REFERENCED MEASURE:

Questions

1. The inlet on the evaporator side of the orifice tube feels __________ to the touch of a properly operating system.
    a. Cold
    b. Hot
    c. Warm
2. An item used to store and dry refrigerant.
3. A restriction in the condenser would reduce:
    a. Cooling
    b. Pressure
    c. Refrigerant flow
    d. A and C.

Answers

1. Cold
2. Receiver/Drier
3. d

Practical Application:

Inspect refrigeration components and hoses for restrictions.

Method of Evaluation:

Use Checklist Performance Objective 08 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 08 EVALUATION

PERFORMANCE TEST FOR INSPECTING REFRIGERATION COMPONENTS AND HOSES FOR RESTRICTIONS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Attached charging station to air conditioning system.		
2.	Operated air conditioning system, noted system pressures and passenger compartment output temperature at dash vents.		
3.	Compared readings with manufacturer's specifications being sure to factor temperature conversion charts into reading.		
4.	Determined air conditioning charge and added as required.		
5.	Checked lines and hoses for obvious kinks or pinches.		
6.	Checked for restrictions in system if compressor discharge pressure is too high or evaporator pressure is too low.		
7.	Located restrictions by first discharging system and then disconnecting lines at component suspected of having restriction.		
8.	Repaired or replaced malfunctioning component.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS.

PERFORMANCE OBJECTIVE 09

TASK: Inspect air conditioning condenser for air flow restrictions.

STANDARD OF PERFORMANCE OF TASK:

All restrictions which would cause improper air flow to and through condenser must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Follow all safety regulations

RESOURCES:

1. Manufacturer's shop manual.
2. Webster, **Auto Mechanics,** chapters 50, pp. 498-504.
3. Air Conditioning Diagnosis (PTF-9-85-10)

TEACHING ACTIVITIES:

1. Read and discuss appropriate manufacturer's repair procedure.
2. Read and discuss textbook, **Auto Mechanics** chapter 50, pp. 498-504.
3. Demonstrate steps in the performance of the task.
4. Demonstrate safety measures to be followed.
5. Have students complete Performance Evaluation Checklist.

PERFORMANCE OBJECTIVE 09

CRITERION-REFERENCED MEASURE

Questions

1. A condenser with restricted air flow would reduce air conditioning ___________.
2. When removing bugs and other debris from the condenser with compressed air or water, blow or wash from the ___________ side of the condenser.
3. A condenser with reduced air flow would cause a ___________ reading on the high side of gauges.

Answers

1. Cooling
2. Back
3. High

Practical Application:

Inspect air conditioning condenser for air flow restrictions.

Method of Evaluation:

Use Checklist Performance Objective 09 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 09 EVALUATION

PERFORMANCE TEST FOR INSPECTING AIR CONDITIONING CONDENSER FOR AIR FLOW RESTRICTIONS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Gained visual access to air conditioning condenser.	______	______
2. Checked condenser for bent or kinked cooling fins.	______	______
3. Checked for paper, leaves, debris covering fins of condenser or radiator causing blockage.	______	______
4. Inspected grill of vehicle for obvious restrictions of air flow through condenser.	______	______
5. Shined light through condenser fins to verify no obstructions.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE 10

TASK: Inspect control cable operation.

STANDARD OF PERFORMANCE OF TASK:

All binding cables and component must be detected; all excessive play/free-travel must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Follow all safety regulations

RESOURCES:

1. Manufacturer's Shop Manual
2. Webster, **Auto Mechanics,** chapter 50, pp. 498-504
3. Air Conditioning Diagnosis, pp. 8-11.

TEACHING ACTIVITIES:

1. Have students read and discuss manufacturer's recommended procedure.
2. Demonstrate steps in the performance of the task.
3. Demonstrate proper safety measures.
4. Have student read and discuss textbook, **Auto Mechanics,** pp. 498-504.
5. Have students complete Performance Evaluation Checklist.

PERFORMANCE OBJECTIVE 10

CRITERION-REFERENCED MEASURE:

Questions

1. An improperly adjusted control cable could reduce air conditioning ______________.
2. A bent control cable should be ______________.
3. Air doors in the system that are binding could cause a control cable to ______________ or ___________.

Answers

1. Efficiency
2. Replaced
3. Bend or break

Practical Application:

Inspect control cable operation.

Method of Evaluation:

Use Checklist Performance Objective 10 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 10 EVALUATION

PERFORMANCE TEST FOR INSPECTING CONTROL CABLE OPERATION

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Moved control cable lever to both extremes of control.	____	____
2.	Noted any binding or sticking indicating corroded or kinked cables, valves or components of system.	____	____
3.	Noted movement of valves, doors, etc. which may be controlled by cable.	____	____
4.	Determined if cable movement causes full and complete operation of controlled component.	____	____
5.	Checked cables and components for loose or broken part if excessive free-travel is noted during operation.	____	____
6.	Noted faulty components on work order.	____	____

Approved: Yes ____ No ____

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE 11

TASK: Inspect operation of air control doors.

STANDARD OF PERFORMANCE OF TASK:

All defects causing improper operation of air doors must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Follow all safety regulations

RESOURCES:

1. Manufacturer's Shop Manual.
2. Webster, **Auto Mechanics**, pp. 498-499.

TEACHING ACTIVITIES:

1. Have students read and discuss service procedure in manufacturer's service manual.
2. Have students read and discuss textbook **Auto Mechanics** pp. 498-499.
3. Demonstrate proper safety measures.
4. Demonstrate the steps in the performance of the task identified in the performance evaluation.
5. Have students complete Performance Evaluation Checklist.

PERFORMANCE OBJECTIVE 11

CRITERION-REFERENCED MEASURE:

Questions

1. An air control door that does not close tightly could cause:
   a. Heater malfunction
   b. Air conditioner malfunction
   c. Neither a or b
   d. Both a and b.
2. A broken air control door would probably require the removal of the ______________ assembly for repair.
   a. Door
   b. Duct
   c. Heater
   d. A/C compressor
3. Air control doors direct air through the:
   a. Air conditioner outlets
   b. Heater outlets
   c. Defroster outlets
   d. All of the above.

Answers

1. d
2. b
3. d

Practical Application:

Inspect operation of air control doors.

Method of Evaluation:

Use Checklist Performance Objective 11 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 11 EVALUATION

PERFORMANCE TEST FOR INSPECTING OPERATION OF AIR CONTROL DOORS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Operated air conditioning or heating system in all modes to check if air control doors are working; noted air flow from various ducts in different mode positions.	____	____
2.	Located and gained access to air control door suspected of malfunctioning.	____	____
3.	Operated control switch of malfunctioning air door to determine if problem is in door or control switch.	____	____
4.	Manually operated door to detect broken or binding parts.	____	____
5.	Noted any faulty components and corrective action taken on work order.	____	____

Approved Yes ____ No ____

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS.

PERFORMANCE OBJECTIVE NO. 12

TASK: Identify causes of heater temperature control problems.

STANDARD OF PERFORMANCE OF TASK:

All causes of heater temperature control problems must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Test thermometer

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Use test thermometer
3. Follow all safety regulations

RESOURCES:

1. Manufacturer's Shop Manual.
2. Webster, **Auto Mechanics**, pp. 498-499.
3. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 714-715, 717.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook **Auto Mechanics**, pp. 498-499.
2. Have students read textbook **Auto Mechanics: Theory And Service**, pp. 714, 715, 717.
3. Have students explain two possible causes of heater temperature control problems.
4. Demonstrate steps in the performance of the task.
5. Have students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE NO. 12

CRITERION-REFERENCED MEASURE:

1. A defective engine ____________ could cause heater not to supply heated air.
    a. Thermostat
    b. Engine fan
    c. Temperature gauge
2. Heater core problems would require:
    a. Replacing
    b. Cleaning
    c. Removal
    d. All of the above.
3. Heater temperature control problems could be caused by:
    a. Defective control
    b. Restricted coolant flow
    c. Defective heater control valve
    d. All of the above.
4. Improper heater operation may be simply a __________ __________.
    a. Blown fuse
    b. Water pump
    c. Restricted heater core
    d. None of the above

Answers

1. a
2. d
3. d
4. a

Practical Application:

Identify causes of heater temperature control problems.

Method of Evaluation:

Use Checklist Performance Objective 12 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 12 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING CAUSES OF HEATER TEMPERATURE CONTROL PROBLEMS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Operated engine until normal operating temperature was reached.		
2.	Turned blower motor to high and set for maximum heat while noting outlet temperature.		
3.	Moved lever to maximum cold setting and observed changing temperature.		
4.	Compared with manufacturer's temperature specifications.		
5.	Moved temperature lever while observing water valve operation or temperature door operation to determine if fault was in control cable.		
6.	Verified blower motor was operating and air ducts are restricted.		
7.	Checked water temperature in heater hose by feeling for temperature changes at inlet and outlet of heater radiator.		
8.	Checked inlet and outlet of heater radiator.		
9.	Released pressure on cooling system.		
10.	Disconnected heater outlet hose.		
11.	Plugged connection on engine where hose was attached.		
12.	Directed hose into suitable container and checked for sufficient coolant flow while operating engine.		

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
13.	Checked both sides of water control valve in same manner to pinpoint flow restrictions.	____	____
14.	Checked hoses for any obvious kinking or pinching.	____	____
15.	Noted any faulty components and corrective action taken on work order.	____	____

Approved: Yes ___ No ___

Evaluator's Signature Date

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE NO. 13

TASK: Inspect air conditioner clutch assembly.

STANDARD OF PERFORMANCE OF TASK:

All malfunctions of clutch operation, defective parts, and unusual noises must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Read and interpret manufacturer's precautions

RESOURCES:

1. deKryger, et al., **Auto Mechanics:** Theory and Service, pp. 723, 724.
2. Manufacturer's Shop Manual
3. **Air Conditioning Diagnosis,** Filmstrip MSJ-AT-K-2A

TEACHING ACTIVITIES:

1. Have students read and discuss textbook, **Auto Mechanics: Theory and Service,** pp. 723-724.
2. Show and discuss filmstrip **Air Conditioning Diagnosis,** MSJ-AT-K-2A.
3. Have students read and discuss service procedure in manufacturer's shop manual.
4. Demonstrate the steps in the performance of the task as identified in the performance evaluation.

PERFORMANCE OBJECTIVE NO. 13

CRITERION-REFERENCED MEASURE:

Questions

1. An air conditioner compressor clutch that is noisy engaging may need to be ____________.
   a. Replaced
   b. Ignored
   c. Adjusted
2. Compressor clutches that do not engage may have excessive:
   a. Air gap
   b. Wear
   c. Both a and b
   d. Neither a or b.
3. A burned clutch would need:
   a. Replacing
   b. Belt adjusted
   c. Recharging.

Answers

1. a
2. a
3. a

Practical Application:

Inspect air conditioner clutch assembly.

Method of Evaluation:

Use Checklist Performance Objective 13 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 13 EVALUATION

PERFORMANCE TEST FOR INSPECTING AIR CONDITIONER CLUTCH ASSEMBLY

Student's Name ______________________ **Date** ______________

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Started engine and observed compressor clutch while engaging and disengaging air conditioner system.	______	______
2.	Determined if clutch was engaging and disengaging compressor crisply with no dragging, slippage or unusual noises.	______	______
3.	Inspected for burned or broken parts.	______	______
4.	Checked for loose or broken electrical connections.	______	______
5.	Checked released clutch air gap and compared with manufacturer's specifications.	______	______
6.	Noted any faulty components and corrective action taken on work order.	______	______

Approved: Yes ___ No ___

Evaluator's Signature ______________________ **Date** ______________

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE 14

TASK: Inspect blower motor operation.

STANDARD OF PERFORMANCE OF TASK:

All unusual noises or loose or broken parts must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Follow safety regulations

RESOURCES:

1. Manufacturer's Shop Manual.
2. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 721-723.

TEACHING ACTIVITIES:

1. Have students read textbook **Auto Mechanics: Theory and Service**, pp. 721-723.
2. Have students explain blower motor operation. (i.e., voltage requirements, speed, noise etc.)
3. Have students read and discuss service procedure in manufacturer's shop manual.
4. Demonstrate the steps and safety measures in the task.
5. Have students demonstrate the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 14

CRITERION-REFERENCED MEASURE:

Questions

1. A blown __________ would cause blower not to operate.
2. A blower motor that is noisy would need to be ______________.
3. A defective blower ____________ would prevent blower operation.
4. List four possible causes of a blower motor not operating.

   ___________ ___________ ___________ ___________

Answers

1. Fuse
2. Replaced
3. Switch
4. Broken wire
   Blown fuse
   Foreign matter in motor
   Defective switch
   Defective relay
   Defective resistor

Practical Application:

Inspect blower motor operation.

Method of Evaluation:

Use Checklist Performance Objective 14 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 14 EVALUATION

PERFORMANCE TEST FOR INSPECTING BLOWER MOTOR OPERATION

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Turned on ignition and operated blower motor at all available speeds.	________	________
2.	Checked for air flow and abnormal noises or vibrations.	________	________
3.	Inspected heater motor attachments and electrical connections for loose, broken or corroded parts.	________	________
4.	Gained access to heater motor fan or squirrel cage and inspected for leaves and other foreign matter if motor made unusual fluttering sounds when operated.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE 15

TASK: Inspect heater hoses for condition and leaks.

STANDARD OF PERFORMANCE OF TASK:

All leaks, cracks, kinks, breaks or soft spot in hoses must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Cooling system pressure tester

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Use cooling system pressure tester
3. Follow safety precautions

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 161-162, 714.
2. Manufacturer's Shop Manual.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook, **Auto Mechanics: Theory And Service,** pp. 161, 162, 714.
2. Demonstrate the differences in hose conditions using new and old hoses as examples.
3. Have students read and be able to explain the service procedure in manufacturer's shop manual.
4. Demonstrate the steps in the task, including safety measures.
5. Have students demonstrate the steps in the performance of the task identified in the performance evaluation.
6. Demonstrate the use of a cooling system pressure tester.

PERFORMANCE OBJECTIVE 15

CRITERION-REFERENCED MEASURE:

Questions

1. A loose heater hose clamp would cause a hose to ____________.
    a. Leak
    b. Break
    c. Bend
2. Heater hoses that are cracked or hard should be ____________.
    a. Taped
    b. Replaced
    c. Ignored
3. When replacing heater hoses always use the proper __________ and __________.

Answers

1. a
2. b
3. Size, length

Practical Application:

Inspect heater hoses for condition and leaks.

Method of Evaluation:

Use Checklist Performance Objective 15 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 15 EVALUATION

PERFORMANCE TEST FOR INSPECTING HEATER HOSES FOR CONDITION AND LEAKS

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Inspected heater hoses for obvious kinks or defects such as cuts, cracks, soft spots and broken clamps.	________	________
2.	Pressurized cooling system and observed hoses for bulging or leaking, especially at connections.	________	________
3.	Checked clamps for tightness.	________	________
4.	Noted any faulty components and corrective action taken on work order.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: AUTO HEATING, COOLING, AND AIR CONDITIONING SYSTEM DIAGNOSIS

PERFORMANCE OBJECTIVE 16

TASK: Check heater water control valve operation.

STANDARD OF PERFORMANCE OF TASK:

All leaks and all binding or broken parts must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit.

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Read and interpret Manufacturer's Shop Manual.
3. Use vacuum gauge and vacuum pump.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, p. 714.
2. Manufacturer's Shop Manual.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook, **Auto Mechanics: Theory And Service**, p. 714.
2. Have the students read service procedure in manufacturer's shop manual.
3. Have students explain manufacturer's service procedure.
4. Demonstrate safety measures and steps in tasks.
5. Have students demonstrate the steps in the performance of the task identified in the performance evaluation.
6. Demonstrate the use of a vacuum gauge and pump for testing vacuum leaks.

PERFORMANCE OBJECTIVE 16

CRITERION-REFERENCED MEASURE:

Questions

1. Most heater control valves operate by:
   a. Vacuum
   b. Manual
   c. Both a and b
   d. Neither a or b.
2. If a heater control valve leaks it must be ______________.
   a. Repaired
   b. Replaced
   c. Ignored
3. A heater valve that is stuck open will:
   a. Increase coolant flow
   b. Decrease coolant flow
   c. Not have any affect on coolant flow
   d. No control of coolant flow through heater.

Answers

1. c
2. b
3. d

Practical Application:

Check heater water control valve operation.

Method of Evaluation:

Use Checklist Performance Objective 16 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 16 EVALUATION

PERFORMANCE TEST FOR CHECKING HEATER WATER CONTROL VALVE OPERATION

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Operated heater temperature control lever or mode lever while observing heater control valve movement.	___	___
2.	Checked control valve water temperature on both sides of valve by feeling hoses with engine at normal operating temperature while also moving temperature select or mode lever at dash.	___	___
3.	Allowed a few minutes for temperatures to stabilize.	___	___
4.	Inspected valve for binding or broken parts.	___	___
5.	Inspected for coolant leaks.	___	___
6.	Inspected for air leaks if vacuum operated.	___	___
7.	Noted any faulty components and corrective action taken on work order.	___	___

Approved: Yes ___ No ___

Evaluator's Signature **Date**

MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 17

TASK: Test vacuum components.

STANDARD OF PERFORMANCE OF TASK:

All causes of vacuum leaks or obstructions must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Vacuum gauge/pump

ENABLING OBJECTIVES:

1. Use vacuum gauge/pump
2. Use standard tool kit

RESOURCES:

1. **Air Conditioning Diagnosis** PTF-9-85-10, pp. 7, 10, 11.
2. Manufacturer's Shop Manual.

TEACHING ACTIVITIES:

1. Have students read and discuss manual, **Air Conditioning Diagnosis** pp. 7, 10, 11.
2. Have students read service procedure in manufacturer's manual.
3. Demonstrate safety measures.
4. Demonstrate steps in task.
5. Have students demonstrate the steps in the performance of the task, identified in performance evaluation.

PERFORMANCE OBJECTIVE 17

CRITERION-REFERENCED MEASURE:

Questions

1. A vacuum motor that is leaking must be:
   a. Replaced
   b. Repaired
   c. Plugged
   d. Ignored.
2. A leaking vacuum control valve that is broken must be:
   a. Glued back together
   b. Adjusted
   c. Repaired
   d. Replaced.
3. Vacuum components that do not work properly could be:
   a. Loose manifold vacuum hose
   b. Needing to be replaced
   c. Stuck
   d. All of the above.

Answers

1. b
2. d
3. d

Practical Application:

Test vacuum components.

Method of Evaluation:

Use Checklist Performance Objective 17 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 17 EVALUATION

PERFORMANCE TEST FOR TESTING VACUUM COMPONENTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Gained access to manifold.	______	______
2.	Checked component for operation visually, if possible.	______	______
3.	Attached vacuum test gauge to vacuum control line.	______	______
4.	Created and measured vacuum for each mode.	______	______
5.	Compared readings with manufacturer's specifications.	______	______
6.	Identified cause of variation (leak or restriction).	______	______
7.	Reattached lines.	______	______
8.	Repaired or replaced malfunctioning component.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 18

TASK: R & R Refrigerant lines.

STANDARD OF PERFORMANCE OF TASK:

Connections must not leak and the lines must be routed according to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Manifold gauges
Vacuum pump
Refrigerant oil
New line
O-ring assortment
Cleaning rag
Halide or electronic leak detector

ENABLING OBJECTIVES:

1. Use vacuum pump
2. Use leak detector
3. Use manifold gauges

RESOURCES:

1. **Air Conditioning Diagnosis** PTF-9-85-10, pp. 13, 14.
2. Manufacturer's Shop Manual.
3. **Basic Air Conditioning Systems,** Filmstrip MPI-8010.

TEACHING ACTIVITIES:

1. Have students read and discuss manual, **Air Conditioning Diagnosis** PTF-9-85-10, pp. 13, 14.
2. Show and discuss filmstrip, **Basic Air Conditioning Systems** MPI-8010.
3. Have students list two dangers of working with R-12, i.e., danger to skin, danger to eyes etc.
4. Demonstrate steps in task.
5. Have students demonstrate the steps in the performance of the task, in the performance evaluation.

PERFORMANCE OBJECTIVE 18

CRITERION-REFERENCED MEASURE

Questions

1. A leaking hose should be:
   a. Replaced
   b. Taped
   c. Repaired
   d. None of the above.
2. A hose that is leaking at a fitting could possibly be:
   a. Tightened
   b. Loose
   c. Missing an "O" ring
   d. All of the above.
3. When a hose is replaced it should be:
   a. Same size and length of original
   b. Routed same as original
   c. Both a and b
   d. Neither a or b.

Answers

1. a
2. d
3. c

Practical Application:

Remove and replace refrigerant lines.

Method of Evaluation:

Use Checklist Performance Objective 18 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 18 EVALUATION

PERFORMANCE TEST FOR R & R REFRIGERANT LINES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Attached manifold gauges to Schrader fittings or service valves.		
2.	Purged or drained system.		
3.	Disconnected refrigerant line at fittings.		
4.	Removed line.		
5.	Cleaned fitting ends.		
6.	Checked and replaced O-rings, if required.		
7.	Applied a light coating of refrigerant oil to fitting ends.		
8.	Installed new line.		
9.	Evacuated and recharged system.		
10.	Tested fittings for leaks with electronic or halide leak detector.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 19

TASK: Fabricate refrigerant lines.

STANDARD OF PERFORMANCE OF TASK:

Hose must be of proper length and angle and leak proof at fittings.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Knife or razor blade
Refrigerant oil
Bulk hose
Hose fittings
Clamps

ENABLING OBJECTIVES:

1. Follow safety regulations
2. Select proper tools

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 726-728.
2. Manufacturer's Shop Manual

TEACHING ACTIVITIES:

1. Have students read and discuss textbook, **Auto Mechanics: Theory and Service**, pp. 726-728.
2. Have students read service procedure in manufacturer's shop manual.
3. Demonstrate the proper procedure of fabricating a refrigerant line.
4. Have the students demonstrate his/her ability to determine hose size and length.
5. Have the student demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 19

CRITERION-REFERENCED MEASURE:

Questions

1. When replacing an air conditioning hose, the replacement hose should be of the same:
   a. Structure
   b. Material
   c. Length
   d. Diameter
   e. All of these.
2. In fabricating new hoses care should be taken to insure against:
   a. Dirt in hose
   b. Bits of loose particles in hose
   c. Moisture in hose
   d. None of the above
   e. All of the above.
3. What type of clamp should be used on air conditioning hoses?

Answers

1. e
2. e
3. Follow manufacturer's recommendations.

Practical Application:

Fabricate refrigerant lines.

Method of Evaluation:

Use Checklist Performance Objective 19 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 19 EVALUATION

PERFORMANCE TEST FOR FABRICATING REFRIGERANT LINES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Selected hose size.	________	________
2.	Cut hose to length.	________	________
3.	Selected proper fittings.	________	________
4.	Lubricated fitting ends to be inserted in hose.	________	________
5.	Inserted fittings and clamp ends with air conditioning hose clamps.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 20

TASK: R & R vacuum motor.

STANDARD OF PERFORMANCE OF TASK:

Motor must be mounted in design position, all line connections are secure, doors and cover correctly reinstalled, and the system operates as designed.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Vacuum gauge/pump
Replacement motor and hardware
Putty sealer

ENABLING OBJECTIVES:

1. Use vacuum gauge/pump
2. Use standard tool kit

RESOURCES:

1. **Air Conditioner Service Manual.**

TEACHING ACTIVITIES:

1. Have the students draw a vacuum motor, and explain how it operates.
2. Have student read repair procedure in **Air Conditioner Service Manual.**
3. Have student explain repair in procedure.
4. Demonstrate safety measures.
5. Demonstrate steps in the performance of the task.
6. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 20

CRITERION-REFERENCED MEASURE:

Questions

1. Vacuum motor action causes the mode door:
   a. To open
   b. To close
   c. Both a and b
   d. Neither a or b.
2. Always replace defective vacuum motor(s) with the same _________ and type as original.
   a. Color
   b. Size
   c. Gearing
   d. None of the above.
3. Vacuum motors usually are either:
   a. Single action
   b. Double action
   c. Both a and b
   d. Neither a or b.

Answers

1. c
2. b
3. c

Practical Application:

Remove and replace vacuum motor.

Method of Evaluation:

Use Checklist Performance Objective 20 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 20 EVALUATION

PERFORMANCE TEST FOR R & R VACUUM MOTOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Removed coverings.		
2.	Disconnected vacuum line(s).		
3.	Removed mode door rods.		
4.	Disconnected vacuum motor.		
5.	Mounted new vacuum motor.		
6.	Reconnected mode door rods.		
7.	Tested vacuum motor with vacuum source.		
8.	Reconnected vacuum lines.		
9.	Replaced cover.		

Approved Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 21

TASK: Test clutch thermostatic switch.

STANDARD OF PERFORMANCE OF TASK:

Any deviation from manufacturer's specified operating temperature must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Voltmeter or test light
Thermometer

ENABLING OBJECTIVES:

1. Use voltmeter
2. Use ohmmeter
3. Use test light

RESOURCES:

1. **Air Conditioning Diagnosis,** PTF-9-85-10, pp. 9, 10.
2. Manufacturer's Shop Manual.
3. **Air Conditioning Diagnosis,** Filmstrip, MPI-8009.
4. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 23, 24, 25.

TEACHING ACTIVITIES:

1. Have students read pages 23, 24, 25 textbook, **Auto Mechanics: Theory and Service.**
2. Have students read **Air Conditioning Diagnosis,** PTF-9-85-10, pp. 9, 10.
3. Have students explain the differences between an open circuit and a continuous circuit.
4. Show and discuss filmstrip, **Air Conditioning Diagnosis,** MPI-8009.
5. Demonstrate the steps in the performance of the task.
6. Have students complete the performance evaluation.

PERFORMANCE OBJECTIVE 21

CRITERION-REFERENCED MEASURE:

Questions

1. A thermostatic switch that is staying closed too long:
   a. Causes high pressure readings.
   b. Causes low pressure readings.
   c. Does not have any effect on cooling
   d. None of the above.
2. A thermostatic switch that opens too early:
   a. Has no affect on cooling
   b. Causes low pressure reading
   c. Reduces cooling
   d. Both b and c
   e. None of the above.
3. The thermostatic switch controls when compressor:
   a. Cuts off
   b. Cuts on
   c. Cycles
   d. All of the above
   e None of the above.

Answers

1. a
2. d
3. d

Practical Application:

Test clutch thermostatic switch.

Method of Evaluation:

Use Checklist Performance Objective 21 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 21 EVALUATION

PERFORMANCE TEST FOR TESTING CLUTCH THERMOSTATIC SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for accuracy.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located switch.	______	______
2.	Gained access.	______	______
3.	Tested for voltage at switch terminals using a voltmeter or test light.	______	______
4.	Tested for current through switch using a meter.	______	______
5.	Operated system at maximum cooling with blower on high.	______	______
6.	Measured air temperature at the evaporator or the closest air duct to the evaporator.	______	______
7.	Compared cut-in/cut-out operation of compressor clutch, in relation to air temperature, with manufacturer's specifications.	______	______
8.	Noted any faulty components and corrective action taken on work order.	______	______

Approved: Yes ___ No ___

Evaluator's Signature Date

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 22

TASK: R & R clutch thermostatic switch.

STANDARD OF PERFORMANCE OF TASK:

Switch must be installed according to manufacturer's procedures so as to activate/deactivate at specified temperature.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement switch
Tape or sealer for capillary tube
Thermometer

ENABLING OBJECTIVES:

1. Use thermometer
2. Use standard tool kit
3. **Air Conditioner Service Manual**

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 723, 725.
2. Manufacturer's Shop Manual.

TEACHING ACTIVITIES:

1. Have students read textbook, **Auto Mechanics: Theory and Service**, pp. 723, 725.
2. Have students read and discuss service procedure in **Air Conditioner Service Manual.**
3. Have students explain the function of a thermostatic switch.
4. Demonstrate safety measures.
5. Demonstrate steps in the performance of the tasks.
6. Have the students demonstrate the steps in performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 22

CRITERION-REFERENCED MEASURE:

Questions

1. A clutch thermostatic switch that is defective:
   a. Should be repaired
   b. Should be replaced
   c. Both a and b
   d. Neither a or b.
2. Clutch thermostatic switch(s) should always be replaced:
   a. With the same type
   b. With any type
   c. With the same color
   d. None of the above.
3. Clutch thermostatic switches control:
   a. Compressor cycling
   b. Air conditioning temperature
   c. Both a and b
   d. Neither a or b.

Answers

1. b
2. a
3. c

Practical Application:

Remove and replace thermostatic switch.

Method of Evaluation:

Use Checklist Performance Objective 22 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 22 EVALUATION

PERFORMANCE TEST FOR R & R THERMOSTATIC SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located switch.		
2.	Gained access.		
3.	Removed any tape or sealant from capillary tube.		
4.	Removed capillary sensing device.		
5.	Removed switch mounting bolts.		
6.	Installed new switch and secured in place.		
7.	Attached capillary tube to the depth in the evaporator specified by manufacturer.		
8.	Replaced tape or sealer on capillary tube.		
9.	Attached electrical connections.		
10.	Replaced any obstructions which were removed for access.		
11.	Tested for operation within specified temperature ranges.		

Approved: Yes ___ No ___

Evaluator's Signature Date

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 23

TASK: R & R magnetic clutch assembly.

STANDARD OF PERFORMANCE OF TASK:

Clutch assembly must engage and disengage fully and be installed according to manufacturer's procedures.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Clutch holding tool
Clutch hub puller
Snap ring pliers
New clutch and coil assembly
Torque wrench

ENABLING OBJECTIVES:

1. Use clutch tools
2. Use torque wrench
3. Use standard tool kit

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, p. 723.
2. Air Conditioning Specialist (Local auto shop).
3. Manufacturer's Shop Manual.

TEACHING ACTIVITIES:

1. Have students read textbook, **Auto Mechanics: Theory and Service**, p. 723.
2. Have students read and discuss manufacturer's service procedure.
3. Discuss the different types of magnetic clutches in use.
4. Have a local air conditioning specialist demonstrate the task.
5. Have the students demonstrate the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 23

CRITERION-REFERENCED MEASURE:

Questions

1. A clutch magnetic coil that is burned or cracked:
   a. Should be replaced
   b. Should be repaired
   c. Both a and b
   d. Neither a or b.
2. A magnetic clutch that is slipping may need:
   a. Air gap adjusted
   b. To be cleaned
   c. Neither a or b
   d. Both a and b.
3. The magnetic clutch bolt or nut, should always be:
   a. Tightened with socket
   b. Torqued to specification
   c. Hand tightened
   d. Tightened with air wrench.

Answers

1. a
2. d
3. b

Practical Application:

R & R magnetic clutch assembly.

Method of Evaluation:

Use Checklist Performance Objective 23 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 23 EVALUATION

PERFORMANCE TEST FOR R & R MAGNETIC CLUTCH ASSEMBLY

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Removed electrical connection; removed compressor if necessary		
2.	Held clutch and removed center shaft nut.		
3.	Removed clutch hub assembly.		
4.	Removed coil assembly.		
5.	Installed new coil.		
6.	Installed new clutch hub assembly.		
7.	Reinstalled center shaft nut and torque to manufacturer's specifications.		
8.	Reinstalled compressor, if necessary.		
9.	Reattached electrical connection.		
10.	Tested operation.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 24

TASK: R & R Compressor Seals.

STANDARD OF PERFORMANCE OF TASK:

Seals must be installed according to manufacturer's procedures without leaks.

SOURCE OF STANDARD:

Standard tool kit
Manifold gauge set
O-ring seal kit
Refrigerant oil
Shop cloths
Leak detector
Refrigerant

ENABLING OBJECTIVES:

1. Use manifold gauge set
2. Use leak detector
3. Use standard tool kit

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 725, 726.
2. Compressor Seals (3 types).
3. **Air Conditioner Service Manual.**
4. **Air Conditioning Diagnosis** Filmstrip, MPI-8009

TEACHING ACTIVITIES:

1. Have the students read and discuss textbook, **Auto Mechanics: Theory and Service**, pp. 725, 726.
2. Have the students identify two types of compressor seals.
3. Have students read service procedure in Manufacturer's Shop Manual.
4. Show and discuss filmstrip **Air Conditioning Diagnosis** MPI-8009.
5. Demonstrate the task and safety procedures.
6. Have students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 24

CRITERION-REFERENCED MEASURE:

Questions

1. When removing old shaft seal, care should be taken not to:
    a. Damage old seal
    b. Damage compressor shaft
    c. Loose air conditioner charge
    d. None of the above.
2. When installing new seal, always lubricate seal with:
    a. Motor oil
    b. 3 inch machine oil
    c. Air conditioning oil
    d. Vaseline.
3. It is normal for a new seal to:
    a. Leak a small amount
    b. Leak a large amount
    c. Never leak
    d. All of the above.

Answers

1. b
2. c
3. c

Practical Application:

R & R Compressor seals.

Method of Evaluation:

Use Checklist Performance Objective 24 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 24 EVALUATION

PERFORMANCE TEST FOR R & R COMPRESSOR SEALS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Purged system.		
2.	Removed lines.		
3.	Removed old seals according to manufacturer's procedures.		
4.	Cleaned fittings and applied light coat of refrigerant oil.		
5.	Installed new seals according to manufacturer's procedures.		
6.	Reinstalled lines.		
7.	Evacuated and recharged system.		
8.	Checked for leaks.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 25

TASK: Check compressor oil level.

STANDARD OF PERFORMANCE OF TASK:

Oil level not in accordance with manufacturer's specifications must be detected.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Manifold gauge set
Shop cloths
Air conditioner oil level dipstick set
Graduated measure container

ENABLING OBJECTIVES:

1. Use service manuals
2. Use manifold gauge set
3. Use graduated measure container

RESOURCES:

1. **Air Conditioning Diagnosis,** PTF-9-85-10, pp. 13, 14
2. **Air Conditioner Service Manual**

TEACHING ACTIVITIES:

1. Have students read and discuss manual, **Air Conditioning Diagnosis** pp. 13, 14, PTF-9-85-10.
2. Have the students read and list manufacturer's service procedure.
3. Demonstrate safety measure.
4. Demonstrate steps in the performance of the task.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 25

CRITERION-REFERENCED MEASURE:

Questions

1. If oil needs to be added to system, always follow:
    a. Your own belief
    b. Manufacturer's recommendations
    c. Instructor's recommendations
    d. None of the above.
2. When adding oil to the compressor, usually the system:
    a. Must be purged
    b. Must be recharged
    c. Must be evacuated
    d. All of the above.
3. Most auto air conditioners use what type of oil?
    a. Motor oil
    b. SAE 10E300 Oil
    c. Special Air Conditioner Oil
    d. None of the above.

Answers

1. b
2. d
3. c

Practical Application:

Check compressor oil level.

Method of Evaluation:

Use Checklist Performance Objective 25 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 25 EVALUATION

PERFORMANCE TEST FOR CHECKING COMPRESSOR OIL LEVEL

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Purged freon from system.		
2.	Removed compressor (rotary compressors only).		
3.	Drained oil into measuring device, checked manufacturer's specifications (rotary compressors).		
4.	Cleaned area around oil plug located on top or side of compressor (piston compressor).		
5.	Removed plug and inserted proper dipstick into compressor and made note of manufacturer's required oil level (piston compressor).		
6.	Reinstalled plug and/or compressor.		
7.	Evacuated and recharged system.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE NO. 26

TASK: R & R dryer.

STANDARD OF PERFORMANCE OF TASK:

Dryer must be installed according to manufacturer's procedures without leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement dryer unit
Manifold gauges and vacuum pump
Refrigerant oil
Shop cloths
Refrigerant
Leak detector.

ENABLING OBJECTIVES:

1. Use vacuum pump.
2. Use standard tool kit.

RESOURCES:

1. **Air Conditioner Service Manual**
2. **Manufacturers Shop Manual.**
3. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 724-728.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook, **Auto Mechanics: Theory and Service**, pp. 724-728.
2. Have the students draw a schematic of air conditioner system, showing placement of dryer.
3. Explain safety measures to be followed.
4. Have students list manufacturer's service procedure.
5. Demonstrate steps in the performance of the task.

PERFORMANCE OBJECTIVE NO. 26

CRITERION-REFERENCED MEASURE:

Questions

1. The air conditioner dryer:
   a. Stores oil
   b. Removes moisture
   c. Both a and b
   d. Neither a or b.
2. When replacing a dryer, you should always:
   a. Measure amount of oil in old dryer
   b. Replace same amount of oil taken from old dryer
   c. Follow manufacturer's instructions
   d. None of the above.
3. New dryer should be same:
   a. Type as old
   b. Size as old
   c. As recommended by manufacturer
   d. All of the above.

Answers

1. c
2. c
3. c

Practical Application:

R & R dryer.

Method of Evaluation:

Use Checklist Performance Objective 26 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 26 EVALUATION

PERFORMANCE TEST FOR R & R DRYER

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located dryer.		
2.	Discharged system.		
3.	Removed line fittings from dryer.		
4.	Removed mounting hardware.		
5.	Removed dryer.		
6.	Cleaned fittings and installed new O-rings if required.		
7.	Applied light coat of refrigerant oil to fittings on lines and dryer.		
8.	Attached replacement dryer with mounting hardware.		
9.	Attached line fittings.		
10.	Evacuated and recharged system.		
11.	Leak checked and tested system.		

Approved: Yes ____ No ____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 27

TASK: R & R condenser.

STANDARD OF PERFORMANCE OF TASK:

Condenser must be installed according to manufacturer's procedures without leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

STANDARD OF PERFORMANCE OF TASK:

Standard tool kit
Replacement condenser
O-ring kit
Refrigerant oil
Manifold gauge set and vacuum pump
Refrigerant
Leak detector

ENABLING OBJECTIVES:

1. Use manufacturer's shop manual
2. Use leak detector
3. Use manifold gauge set

RESOURCES:

1. **Manufacturer's Shop Manual.**
2. **Air Conditioner Service Manual.**

TEACHING ACTIVITIES:

1. Have students read and discuss service procedure in **Manufacturer's Shop Manual.**
2. Identify items to be removed to gain access to condenser.
3. Explain procedure to be followed in removing condenser.
4. List all safety procedures to be followed.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 27

CRITERION-REFERENCED MEASURE:

Questions

1. When replacing a condenser always:
   a. Use the same size
   b. Measure oil taken from condenser
   c. Follow manufacturer's recommendations
   d. Both b and c
   e. Both a and b
2. A replacement condenser should be mounted:
   a. With screws
   b. With bolts
   c. Both a and b
   d. Per manufacturer's instructions.
3. Replacement of a condenser requires:
   a. Recharging system
   b. Leak testing
   c. Both a and b
   d. None of the above.

Answers

1. c
2. d
3. c

Practical Application:

R & R condenser.

Method of Evaluation:

Use Checklist Performance Objective 27 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 27 EVALUATION

PERFORMANCE TEST FOR R & R CONDENSER

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Purged system.		
2.	Removed grill or radiator (if needed).		
3.	Removed hoses.		
4.	Removed condenser support brackets.		
5.	Removed condenser.		
6.	Installed new condenser with attaching hardware.		
7.	Put a light coat of refrigerant oil on lines and replaced O-rings if required.		
8.	Reinstalled grill or radiator and lines.		
9.	Evacuated, recharged and leak tested system.		
10.	Performance tested system.		

Approved: Yes ___ No ___

Evaluator's Signature Date

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 28

TASK: R & R evaporator.

STANDARD OF PERFORMANCE OF TASK:

Evaporator must be installed according to manufacturer's procedures without leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement evaporator
Refrigerant oil
O-ring kit
Putty sealer and prestite tape
Manifold gauge set
Refrigerant

ENABLING OBJECTIVES:

1. Select tools
2. Use manifold gauge set
3. Apply putty sealer or prestite tape

RESOURCES:

1. **Air Conditioner Service Manual.**
2. **Air Conditioner Diagnosis**, PTF-9-85-10, p. 14.

TEACHING ACTIVITIES:

1. Have the students read manual, **Air Conditioning Diagnosis** PTF-9-85-10, p. 14.
2. Compare the differences in various manufacturer's air conditioning evaporators.
3. Have the students draw a schematic of an evaporator showing refrigerant flow.
4. Explain safety precautions.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 28

CRITERION-REFERENCED MEASURE:

Questions

1. When replacing evaporator always use the same:
   a. Type as original
   b. Sizes as original
   c. Neither a or b
   d. Both a and b.
2. Always measure the amount of ___________ removed from old evaporator.
   a. Oil
   b. Refrigerant
   c. Moisture
3. When replacing evaporator, there should not be any:
   a. Air leaks at housing
   b. Oil leaks at lines
   c. Refrigerant leaks
   d. All of the above.

Answers

1. d
2. a
3. d

Practical Application:

R & R evaporator.

Method of Evaluation:

Use Checklist Performance Objective 28 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 28 EVALUATION

PERFORMANCE TEST FOR R & R EVAPORATOR

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Purged system.		
2.	Disconnected lines and electrical connections.		
3.	Removed bolts from evaporator case.		
4.	Separated evaporator case.		
5.	Removed evaporator from case.		
6.	Installed new evaporator in case.		
7.	Reinstalled bolts.		
8.	Sealed case.		
9.	Reconnected lines using new O-rings and refrigerant oil and electrical connectors.		
10.	Evacuated system and recharged system.		
11.	Made leak test and performance test.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 29

TASK: R & R expansion tube.

STANDARD OF PERFORMANCE OF TASK:

Expansion tube must be installed according to manufacturer's procedures without leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement expansion tube
Refrigerant oil
O-ring kit
Manifold gauge set
Vacuum pump
Freon and leak detector
Refrigerant
Fixed orifice tube puller

ENABLING OBJECTIVES:

1. Identify expansion tube
2. Use expansion tube puller
3. Use leak detector

RESOURCES:

1. **Air Conditioning Diagnosis,** PTF-9-85-10, p. 12.
2. Manufacturer's Shop Manual.

TEACHING ACTIVITIES:

1. Have students read manual, **Air Conditioning Diagnosis** PTF-9-85-10, p. 12.
2. Illustrate placement of expansion tube by various manufacturer's specifications.
3. Have the students draw an expansion tube and be able to explain its function.
4. Have students read and follow manufacturer's repair procedure.
5. Explain safety precautions.
6. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 29

CRITERION-REFERENCED MEASURE:

Questions

1. A missing orifice tube could cause:
    a. Low pressure on low side
    b. High pressure on low side
    c. Low pressure on both sides
    d. High pressure on both sides.
2. High pressure on the low side may be caused by:
    a. Bad orifice tube
    b. Clogged evaporator
    c. Too much refrigerant
    d. A bad compressor.
3. The evaporator side of the orifice tube should feel __________ to the touch.
    a. Cold
    b. Warm
    c. Hot

Answers

1. b
2. c
3. a

Practical Application:

R & R expansion tube.

Method of Evaluation:

Use Checklist Performance Objective 29 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 29 EVALUATION

PERFORMANCE TEST FOR R & R EXPANSION TUBE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Purged system.	______	______
2.	Removed line containing fixed orifice tube.	______	______
3.	Removed expansion tube using special tool.	______	______
4.	Oiled new valve and using tool, installed an evaporator.	______	______
5.	Applied oil to fittings and O-rings.	______	______
6.	Reinstalled line and tightened securely.	______	______
7.	Evacuated and recharged.	______	______
8.	Leak tested and performance tested system.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 30

TASK: R & R measured orifice valve/expansion valve.

STANDARD OF PERFORMANCE OF TASK:

Replacement valve must not leak oil or refrigerant and it must be positioned according to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Manifold gauge set
Vacuum pump
Replacement expansion valve
Solvent
Sandpaper
Refrigerant

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Use manifold gauge set
3. Identify expansion valve

RESOURCES:

1. Manufacturer's Shop Manual
2. **Air Conditioner Service Manual.**

TEACHING ACTIVITIES:

1. Have students draw an expansion valve to illustrate refrigerant flow.
2. Have students list manufacturer's repair procedure.
3. Discuss safety measures.
4. Explain steps in the performance of the task.
5. Have students complete criterion referenced material listed.

PERFORMANCE OBJECTIVE 30

CRITERION-REFERENCED MEASURE:

Questions

1. A defective expansion would probably cause:
   a. Extremely low side reading
   b. Extremely high side reading
   c. Low high side readings
   d. None of the above.
2. A restricted expansion valve screen would cause:
   a Erratic cooling
   b. No cooling
   c. Less cooling
   d. More cooling.
3. Expansion valves that do not work properly:
   a. Should be replaced
   b. Should be repaired
   c. Ignored.

Answers

1. a
2. c
3. a

Practical Application:

R & R measured orifice valve/expansion valve.

Method of Evaluation:

Use Checklist Performance Objective 30 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 30 EVALUATION

PERFORMANCE TEST FOR R & R MEASURED ORIFICE VALVE EXPANSION VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Connected manifold gauge set to the air conditioning system.		
2.	Discharged the system.		
3.	Disconnected the expansion valve with an open-end wrench and a fitting wrench.		
4.	Removed the insulation from around the sensor bulb or coil and removed the clamp holding the sensor in place.		
5.	Lifted out the expansion valve along with the sensor.		
6.	Lubricated the threaded connectors with refrigerant oil and connected the lines to the valve.		
7.	Cleaned the remote sensor bulb, and the area of the suction line which contacts the sensor, with solvent and sandpaper.		
8.	Replaced the sensor on the suction line (evaporator outlet) with tape, and insulated the bulb according to manufacturer's procedures.		
9.	Evacuated and recharged the system.		
10.	Performed a leak-test of the system.		
11.	Started the engine and checked the air conditioner for normal operation.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 31

TASK: Test suction throttling valve.

STANDARD OF PERFORMANCE OF TASK:

All defects of suction throttling valve which cause unsatisfactory operation of A/C system must be detected and any leaks must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Charging station

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Attach charging station

RESOURCES:

1. **Automotive Air Conditioner Explained,** Filmstrip B-442.
2. **Air Conditioner Service Manual.**
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Show and discuss **Automotive Air Conditioner Explained,** Filmstrip B-442.
2. Have the student explain the operation of suction throttling valve.
3. Have the student explain the two methods of controlling suction throttling valve.
4. Explain the procedure of adjusting suction throttling valve.
5. Have the student demonstrate the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 31

CRITERION-REFERENCED MEASURE:

Questions

1. Suction throttling valves are:
    a. Manually controlled
    b. Electronically controlled
    c. Both a and b
    d. Both a and c.
2. A leaking suction throttling valve diaphragm could:
    a. Leak refrigerant into atmosphere
    b. Leak refrigerant into engine
    c. Neither a or b
    d. Both a and b.
3. What type of gas would be a result of burning R-12?
    a. Nitrogen
    b. Carbon monoxide
    c Phosgene
    d. None of the above.

Answers

1. d
2. d
3. c

Practical Application:

Testing suction throttling valve.

Method of Evaluation:

Use Checklist Performance Objective 31 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 31 EVALUATION

PERFORMANCE TEST FOR TESTING SUCTION THROTTLING VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Inspected suction throttling valve for obvious defects or oil leaks.		
2.	Connected gauges to A/C system, ran engine on fast idle with A/C at maximum cool.		
3.	Checked for evaporator icing indicating defective suction throttling valve.		
4.	Monitored gauge pressures and compared to manufacturer's specifications for operating temperatures. (If valve inlet pressure is too high this would indicate valve might be stuck open).		
5.	Shut engine off and observed inlet pressure at valve. (If inlet pressure was too low and did not rise when engine was shut off valve was stuck open).		
6.	Removed and inspected valve when its operation was suspect.		
7.	Performed leak test around valve and fittings.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 32

TASK: R & R suction throttling valve.

STANDARD OF PERFORMANCE OF TASK:

Valve must control evaporator temperature to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Suction throttling valve
O-ring seals
Charging station
Refrigerant Oil

ENABLING OBJECTIVES:

1. Select special tools
2. Secure parts
3. Use charging station or manifold gauge set

RESOURCES:

1. Manufacturer's Service Manual.
2. **Air Conditioner Service Manual.**

TEACHING ACTIVITIES:

1. Have the student read service procedure in manufacturer's service manual.
2. Explain service procedure recommended by manufacturer.
3. Have the student list service procedure.
4. Discuss safety precautions with students.
5. Have the student demonstrate the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 32

CRITERION-REFERENCED MEASURE:

Questions

1. A replacement suction throttling valve should be of the same:
    a. Size
    b. Type
    c. Color
    d. Brand.
2. After replacement valve is installed, it should be:
    a. Adjusted
    b. Performance tested
    c. Checked for leaks
    d. All of the above
    e. None of the above.
3. Suction throttling valves control:
    a. Air pressure
    b. Refrigerant speed
    c. Cooling temperature
    d. None of the above.

Answers

1. b
2. d
3. c

Practical Application:

R & R suction throttling valve.

Method of Evaluation:

Use Checklist Performance Objective 32 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 32 EVALUATION

PERFORMANCE TEST FOR R & R SUCTION THROTTLING VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Discharged system.	______	______
2.	Cleaned accumulated dirt and grease from connections and fittings.	______	______
3.	Loosened and disconnected oil bleed line.	______	______
4.	Loosened and disconnected lines at valve.	______	______
5.	Loosened or removed bracket or clamp to which valve was attached.	______	______
6.	Removed valve from vehicle and discarded O-ring seals.	______	______
7.	Lubricated new O-ring seals and installed on new valve or lines.	______	______
8.	Positioned new valve in original position.	______	______
9.	Installed and tightened valve mounting bracket or clamp.	______	______
10.	Connected and tightened refrigerant lines to suction throttling valve being careful not to cut, nick, or kink O-ring seals.	______	______
11.	Connected and tightened oil bleed lines.	______	______
12.	Evacuated and recharged system.	______	______
13.	Leak tested system and conducted performance test of A/C unit.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 33

TASK: R & R compressor.

STANDARD OF PERFORMANCE OF TASK:

Replacement compressor must be installed securely in position specified by manufacturer with all hoses and belts in specified positions with no leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Manifold gauge set
Vacuum pump
R-12 Refrigerant
Compressor
Refrigerant

ENABLING OBJECTIVES:

1. Select proper tools
2. Identify correct parts
3. Use charging station or manifold gauge set

RESOURCES:

1. **Air Conditioner Service Manual.**
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Explain the safety measures that must be taken when handling refrigerant.
2. Demonstrate procedure for evacuating system prior to compressor removal.
3. Discuss manufacturer's repair procedure for compressor removal and installation.
4. Have the students list the steps for removal and installation of various types of compressors.
5. Have the students complete the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 33

CRITERION-REFERENCED MEASURE:

Questions

1. When replacing a compressor, you should always use oil that is recommended by:
   a. Students
   b. Auto shops
   c. Manufacturer
   d. Owner.
2. After replacing compressor, it is necessary to:
   a. Performance test system
   b. Check for noise
   c. Check for leaks
   d. All of the above.
3. If the replacement compressor does not have a clutch, should you?
   a. Install new clutch
   b. Inspect and use old clutch if serviceable
   c. Consult instructor and owner
   d. All of the above.

Answers

1. c
2. d
3. c

Practical Application:

R & R compressor.

Method of Evaluation:

Use Checklist Performance Objective 33 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 33 EVALUATION

PERFORMANCE TEST FOR R & R COMPRESSOR

Student's Name	**Date**
DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Connected manifold gauge set to the system.		
2.	Discharged the air conditioning system if equipped with Schrader-type valves, or the compressor only if equipped with hand-operated service valves.		
3.	Removed the compressor drive belts.		
4.	Disconnected the compressor magnetic clutch wiring.		
5.	Disconnected and capped the compressor discharge and suction lines if compressor was equipped with Schrader-type valves. (Caution: Manifold gauges must read zero before these lines are disconnected).		
6.	Removed manifold gauge if it was connected to the compressor.		
7.	Removed the compressor mounting bolts and lifted the compressor from the engine.		
8.	Placed the replacement compressor on the engine and started the mounting bolts and nuts.		
9.	Checked that the compressor oil level was correct and added oil if necessary.		
10.	Installed new O-rings and/or gaskets and coated with refrigerant oil.		
11.	Coated the threads and seats of the suction and discharged lines with refrigerant oil and connected the lines to the compressor.		

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
12.	Connected the magnetic clutch wiring.		
13.	Installed the compressor drive belts and adjusted tension to manufacturer's specifications; tightened compressor mounting bolts.		
14.	Connected the manifold gauge to the compressor or system.		
15.	Evacuated the compressor or the entire system as appropriate.		
16.	Recharged the system with R-12 refrigerant.		
17.	Tested the system for leaks.		
18.	Checked the system pressure.		
19.	Performance tested the air conditioning system.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 34

TASK: Install air conditioner system.

STANDARD OF PERFORMANCE OF TASK:

Installation is done so as to perform to manufacturer's cooling specifications with no unusual noises, all fasteners are secure and hoses and wiring are routed to avoid premature wear.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Charging station
Refrigerant oil
Air conditioning kit

ENABLING OBJECTIVES:

1. Identify all parts to be used
2. Follow diagrams and instructions
3. Use torque wrench

RESOURCES:

1. **Air Conditioner Installation Manual.**
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Explain type of air conditioner that is being installed.
2. Show schematic of installation procedure of all items.
3. Have the student study schematic and list all items to be removed and special tools to be used.
4. Have the students list items to be installed in the proper sequence.
5. Have the students complete the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 34

CRITERION-REFERENCED MEASURE:

Questions

1. List three items to be checked on air conditioner drive system.
    a. ______________
    b. ______________
    c. ______________.
2. Air conditioner system should be ______________ tested after installation.
3. An air conditioner system that is operating properly will drop inside to outside air:
    a. About 20 degrees
    b. About 40 degrees
    c. About 50 degrees
    d. None of the above.

Answers

1. a. Belt alignment
    b. Pulley noise
    c. Pulley wobble
2. Performance
3. a

Practical Application:

Installing air conditioning system.

Method of Evaluation:

Use Checklist Performance Objective 34 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 34 EVALUATION

PERFORMANCE TEST FOR INSTALLING AIR CONDITIONING SYSTEM

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Referred to manufacturer's instructions to install kit.		
2.	Checked kit components for correct application and determined if all parts were present and not damaged.		
3.	Disconnected battery cable.		
4.	Moved or repositioned parts as necessary under hood to mount condenser, compressor and associated hoses and components.		
5.	Routed hoses and wiring making sure not to interfere with hot or moving parts.		
6.	Mounted condenser so as not to rub against radiator or body of vehicle.		
7.	Removed or repositioned parts at dash as necessary to install evaporator assembly switches, motors etc.		
8.	Installed evaporator, controls, and evaporator drain tube.		
9.	Added oil to compressor if required and installed compressor.		
10.	Lubricated all threaded hose connections and O-rings as hoses are connected.		
11.	Torqued or tightened all fittings and connectors to manufacturer's specifications.		
12.	Evacuated system.		
13.	Reconnected battery cable.		
14.	Charged system with specified amount of refrigerant.		

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
15.	Performance checked system and checked for leaks.	________	________
16.	Checked for unusual noises or improper operation and corrected as necessary.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 35

TASK: R & R low pressure cut out switch.

STANDARD OF PERFORMANCE OF TASK:

Switch must function to manufacturer's specifications for pressure cut off points and must not leak and must be securely installed.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Low pressure cut out switch and seal
Charging station
Refrigerant oil
Refrigerant

ENABLING OBJECTIVES:

1. Select proper parts and tools
2. Use standard tool kit
3. Follow manufacturer's instructions

RESOURCES:

1. **Air Conditioning Diagnosis,** Filmstrip MPI-8009.
2. **Air Conditioning Diagnosis** PTF-9-85-10.
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Review, **Air Conditioning Diagnosis,** pp. 6, 7 PTF-9-85-10.
2. Review, **Air Conditioning Diagnosis,** Filmstrip MPI-8009.
3. Explain function of low pressure cut-out switches.
4. Have the students list the location of various low pressure cut-out switches.
5. Have the students list the procedure recommended by manufacturer in replacing low pressure cut-out switches.

PERFORMANCE OBJECTIVE 35

CRITERION-REFERENCED MEASURE

Questions

1. In the event of a major refrigerant loss and a drop in pressure the low pressure cut-off switch:
    a. Will not allow the compressor to engage
    b. Will cycle the compressor as normal
    c. Both a and b
    d. Neither a or b.
2. Replacement of the low pressure cutout switch can be completed:
    a. Without discharging the system,
    b. By discharging system completely
    c. Both a and b
    d. Neither a or b
3. In some systems the low pressure cutout switch is:
    a. Located in the high side because there is no pressure cycling switch in the system
    b. Always in the low side,
    c. Omitted because the high pressure cutoff switch serves the same purpose,
    d. None of the above.

Answers

1. a
2. b
3. a

Practical Application:

R & R low pressure cutout switch.

Method of Evaluation:

Use Checklist Performance Objective 35 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 35 EVALUATION

PERFORMANCE TEST FOR R & R LOW PRESSURE CUTOUT SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to cut out switch.		
2.	Discharged system.		
3.	Removed electrical connections from switch if used.		
4.	Removed snap ring or bolts securing switch.		
5.	Removed old switch and sealed from system.		
6.	Lubricated new seal or O-ring and installed in switch mounting recess.		
7.	Positioned and installed new switch, being careful not to nick, cut or kink seal.		
8.	Reinstalled snap ring or bolts securing switch, making sure snap ring was fully seated.		
9.	Reattached electrical connections.		
10.	Evacuated.		
11.	Turned on A/C system without starting engine.		
12.	Charged system noting if compressor clutch engaged at manufacturer's specified cut out switch tolerances.		
13.	Performance tested system and checked for leaks.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 36

TASK: R & R high pressure cut out switch.

STANDARD OF PERFORMANCE OF TASK:

Switch must perform to manufacturer's pressure cut out specifications and switch must not leak.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
High pressure cut out switch and seal
Charging station
Refrigerant oil

ENABLING OBJECTIVES:

1. Identify necessary parts
2. Use charging station

RESOURCES:

1. **Air Conditioning Diagnosis,** Filmstrip MPI-8009
2. **Air Conditioning Diagnosis** PTF-8-85-10, pp. 6, 7.
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Have students read and discuss, **Air Conditioning Diagnosis,** pp. 6, 7 PTF-9-85-10.
2. Show and discuss, **Air Conditioning Diagnosis,** Filmstrip MPI-8009.
3. Explain function of high pressure cut out switches.
4. Have the students list the location of various high pressure cut-out switches.
5. Have the student list the steps recommended by manufacturer in replacing high pressure cut-out switch.

PERFORMANCE OBJECTIVE 36

CRITERION-REFERENCED MEASURE:

Questions

1. What is the purpose of the high pressure cut-out switch?
2. How is the high pressure cut-out switch connected to the compressor?
3. What, other than pressure, effects the high pressure cut-out switch?

Answers

1. To prevent excessively high pressures in the system.
2. It acts as a ground to the compressor clutch coil.
3. Temperature.

Practical Application:

R & R high pressure cut-out switch.

Method of Evaluation:

Use Checklist Performance Objective 36 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 36 EVALUATION

PERFORMANCE TEST FOR R & R HIGH PRESSURE CUT-OUT SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Discharged system.		
2.	Located and gained access to switch.		
3.	Loosened and removed electrical connections if used.		
4.	Loosened and removed snap ring or retaining bolts.		
5.	Removed switch and discarded O-ring.		
6.	Lubricated new O-ring with refrigerant oil and installed in switch recess.		
7.	Installed and fully seated new switch being careful not to cut, nick or kink O-ring.		
8.	Reinstalled snap ring making sure it was fully seated or reinstalled and tightened switch mounting bolts.		
9.	Reattached and tightened electrical connections.		
10.	Evacuated system.		
11.	Recharged and leak tested system.		
12.	Performance tested the system.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 37

TASK: R & R drive and idler pulleys.

STANDARD OF PERFORMANCE OF TASK:

Pulleys must be secure to shaft, and in alignment.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement pulleys

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Identify necessary parts
3. Use belt tension gauge

RESOURCES:

1. **Air Conditioner Service Manual.**
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Have the students read service procedure in Manufacturer's Service Manual.
2. Explain function of drive and idler pulleys.
3. Have the students draw several drive and idler pulley arrangements.
4. Have the students explain necessity of proper pulley alignment.
5. Have the students complete the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 37

CRITERION-REFERENCED MEASURE:

Questions:

1. A drive pulley or idler pulley that is not properly aligned, could cause:
   a. Excessive belt wear
   b. Belt to come off
   c. Both a and b
   d. Neither a or b.
2. When replacing either drive or idler pulleys, always use:
   a. Same diameter as original
   b. Same width as original
   c. Neither a or b
   d. Both a and b.
3. A bent or broken pulley should be:
   a. Straightened and reused
   b. Welded and reused
   c. Replaced
   d. None of the above.

Answers

1. c
2. d
3. c

Practical Application:

R & R drive and idler pulleys.

Method of Evaluation:

Use Checklist Performance Objective 37 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 37 EVALUATION

PERFORMANCE TEST FOR R & R DRIVE AND IDLER PULLEYS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Repositioned or moved any parts interfering with removal of pulleys.	________	________
2.	Loosened the adjuster bolts and removed drive belts from pulleys being replaced.	________	________
3.	Loosened and removed brackets, braces, supporting pulleys, etc.	________	________
4.	Loosened and removed pulley mounting.		
5.	Removed pulley from car and installed new pulley in original position.	________	________
6.	Reinstalled pulley mounting bolts.	________	________
7.	Reinstalled brackets, braces, etc.	________	________
8.	Reinstalled drive belts on the pulleys, making sure they are reinstalled in the correct grooves. (Replaced any belts that were cracked or worn).	________	________
9.	Adjusted belts to manufacturer's recommended tensions.	________	________
10.	Reinstalled parts removed to gain access to the pulleys.	________	________
11.	Operated engine while observing belts and pulleys for operation without unusual noises or wobble of pulleys.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 38

TASK: R & R compressor clutch bearing.

STANDARD OF PERFORMANCE OF TASK:

Bearing must turn freely without abnormal drag or noise and must be securely mounted and seated.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Clutch bearing
Clutch removal tool
Charging station
Compressor hose seals
Refrigerant oil
Refrigerant

ENABLING OBJECTIVES:

1. Identify bearing placement
2. Select special tools
3. Select necessary parts

RESOURCES:

1. **Air Conditioner Service Manual.**
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Explain the function and placement of various types of compressor clutch bearings.
2. Select and demonstrate replacement of two types of compressor clutch bearings.
3. Explain safety procedures to be followed.
4. Have student list bearing replacement procedure and special tools needed.
5. Have the students complete the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 38

CRITERION-REFERENCED MEASURE:

Questions

1. A compressor or clutch bearing that is noisy, should be:
   a. Repaired
   b. Replaced
   c. Lubricated
   d. None of the above.
2. A compressor clutch bearing that is seized, would require:
   a. Compressor replacement
   b. Clutch replacement
   c. Bearing replacement
   d. All of the above.
3. If the compressor clutch bearing is leaking grease, the:
   a. Seal should be replaced
   b. Bearing should be replaced
   c. Both a and b
   d. Neither a or b.

Answers

1. b
2. c
3. b

Practical Application:

R & R compressor clutch bearing.

Method of Evaluation:

Use Checklist Performance Objective 38 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 38 EVALUATION

PERFORMANCE TEST FOR R & R COMPRESSOR CLUTCH BEARING

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Discharged air conditioning system.		
2.	Loosened and removed hoses at compressor.		
3.	Plugged holes in lines and compressor to prevent entry of dirt and moisture.		
4.	Loosened and removed compressor mounting bolts and drive belts.		
5.	Removed compressor from vehicle.		
6.	Mounted compressor in vise, using suitable holding fixture if available.		
7.	Loosened and removed bolts, and nuts securing clutch plate assembly to compressor.		
8.	Removed clutch plate using manufacturer's specified tool or pulley.		
9.	Loosened and removed pulley and magnet mounting bolts or snap ring.		
10.	Removed pulley and magnet from compressor.		
11.	Loosened and removed bearing from magnet or pulley.		
12.	Pressed clutch bearing from magnet or pulley.		
13.	Cleaned bearing recess and press new bearing into place.		
14.	Fully seated bearing and installed and tightened retainer, bolts or snap ring.		

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
15.	Reinstalled pulley and magnet onto compressor making sure to index electrical connector to original position.	____	____
16.	Reinstalled and tightened pulley and magnet mounting bolts or snap ring.	____	____
17.	Reinstalled clutch plate.	____	____
18.	Installed and tightened clutch plate mounting bolts or nuts.	____	____
19.	Reinstalled compressor in vehicle and installed and tightened mounting bolts and drive belts.	____	____
20.	Removed seals and plugs from compressor fittings.	____	____
21.	Lubricated new seals with refrigerant oil and installed.	____	____
22.	Removed plugs, connected and tightened lines to compressor.	____	____
23.	Evacuated and leak tested system.	____	____
24.	Recharged and operated air conditioning to check for proper cooling and to detect any unusual noises.	____	____

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 39

TASK: Add oil to compressor.

STANDARD OF PERFORMANCE OF TASK:

Oil level is checked and corrected to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Charging station
Refrigerant oil
Oil level dipstick
Refrigerant

ENABLING OBJECTIVES:

1. Use refrigerant properly
2. Select proper tools
3. Read and interpret manufacturer's manual

RESOURCES:

1. **Air Conditioner Service Manual.**
2. **Air Conditioner Diagnosis** PTF-9-85-10, pp. 13-14.

TEACHING ACTIVITIES:

1. Have student read and discuss using **Air Conditioner Diagnosis,** pp. 13- 14.
2. Explain usage of graduated measuring container.
3. Demonstrate proper procedure for adding compressor oil.
4. Have the students list manufacturer's recommended procedure.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 39

CRITERION-REFERENCED MEASURE:

Questions

1. Overfilling an air conditioner system with oil will:
   a. Increase efficiency
   b. Reduce efficiency
   c. Increase life of compressor
   d. None of the above.
2. Most air conditioner manufacturers recommend:
   a. 727 oil
   b. 426 oil
   c. 525 oil
   d. Any grade will do.
3. Undercharge of air conditioner oil would:
   a. Increase cooling
   b. Shorten life of unit
   c. Cause high gauge readings
   d. None of the above.

Answers

1. b
2. c
3. b

Practical Application:

Adding oil to compressor.

Method of Evaluation:

Use Checklist Performance Objective 39 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 39 EVALUATION

PERFORMANCE TEST FOR ADDING OIL TO COMPRESSOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Operated engine at fast idle and air conditioner on maximum cooling for 10-15 minutes to stabilize system. Shut off system.		
2.	Closed stem type valves at compressor if used to isolate compressor from system.		
3.	Discharged system if compressor cannot be isolated.		
4.	Removed oil level plug from compressor, slowly if system was not discharged.		
5.	Using appropriate dipstick or visual check, noted oil level in compressor.		
6.	Removed compressor from car if it is a Frigidaire A6 or R4 and drain oil. (Caution: Do not check oil in Frigidaire compressors as a routine service, but only if major system repair or from serious oil loss, i.e. broken hose or accident).		
7.	Referred to manufacturer's specifications for amount of oil to add.		
8.	Added oil to compressor using suitable funnel.		
9.	Reinstalled compressor if removed.		

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
10.	Reinstalled oil fill plug if removed.	________	________
11.	Repositioned service valves if used and evacuated system if it was discharged.	________	________
12.	Recharged system and leak tested if necessary.	________	________
13.	Performance tested the system.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 40

TASK: R & R compressor reed valve assembly.

STANDARD OF PERFORMANCE OF TASK:

Reed valve assembly must be installed according to manufacturer's procedures with no internal vacuum or refrigerant leaks, and no leakage around the head gaskets.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Torque wrench
Replacement valve assembly
Replacement gaskets

ENABLING OBJECTIVES:

1. Use torque wrench
2. Use standard tool kit

RESOURCES:

1. Manufacturer's Service Manual
2. **Air Conditioner Service Manual.**

TEACHING ACTIVITIES:

1. Explain the function of the reed valve assembly.
2. Describe the construction of the reed valves.
3. Show examples of various manufacturers reed valves.
4. Have the students draw a set of reed valves and be able to explain how they operate.
5. Have the student list the manufacturer's repair procedure.

PERFORMANCE OBJECTIVE 40

CRITERION-REFERENCED MEASURE:

Questions

1. A bent or broken reed valve could cause:
   a. Decrease in cooling
   b. Increase in cooling
   c. Both a and b
   d. Neither a or b.
2. When servicing reed valve plates in the compressor:
   a. New gaskets should be installed
   b. New gaskets should be coated with refrigerant oil
   c. Neither a or b
   d. Both a and b.
3. No type of sealer should be used on reed valve gaskets because:
   a. Excess sealer could be picked up by refrigerant and be deposited throughout system;
   b. Clogging of the expansion valve screen and other filter screen could result;
   c. Both a and b;
   d. Neither a or b;
   e. None of the above: Sealer should be used on all gaskets.

Answers

1. a
2. d
3. c

Practical Application:

R & R compressor reed valve assembly.

Method of Evaluation:

Use Checklist Performance Objective 40 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 40 EVALUATION

PERFORMANCE TEST FOR R & R COMPRESSOR REED VALVE ASSEMBLY

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Removed compressor from vehicle.	________	________
2.	Removed the head bolts from the compressor and lifted off the head and reed valve assembly.	________	________
3.	Removed gasket material from the cylinder head, reed valve plate and compressor cylinders without scratching the surfaces.	________	________
4.	Examined the reed valve plate to assure the correct placement of the valves.	________	________
5.	Installed new valves in place in the positions specified in the service manual.	________	________
6.	Coated the gaskets with a light coat of refrigerant oil and installed the gaskets, reed valve plate and cylinder head on the compressor.	________	________
7.	Torqued the cylinder head bolts according to the manufacturer's procedures and specifications for foot-pounds of torque.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 41

TASK: R & R muffler hose assembly.

STANDARD OF PERFORMANCE OF TASK:

New hose must be securely mounted in position specified by manufacturer and hose connections must not leak.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Muffler hose assembly
Charging station
Refrigerant oil

ENABLING OBJECTIVES:

1. Use charging station
2. Use standard tool kit
3. Use manifold gauges

RESOURCES:

1. **Air Conditioning Diagnosis,** PTF-9-85-10, pp. 13-14.
2. Manufacturer's Service Manual.
3. **Basic Air Conditioning System,** Filmstrip MPI-8010.

TEACHING ACTIVITIES:

1. Have student read and discuss **Air Conditioning Diagnosis,** PTF-9-85-10, pp. 13 -14.
2. Show and discuss filmstrip, **Basic Air Conditioning Systems** MPI-8010.
3. Have the students list three dangers of working with refrigerant-12.
4. Demonstrate the steps in task.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 41

CRITERION-REFERENCED MEASURE:

Questions

1. Why must hose and muffler assembly and fittings be aligned and positioned in the original position?
    a. To prevent cross threading of fittings
    b. To prevent cutting new seals
    c. A and b
    d. Neither a nor b.
2. Why are braces or brackets used on the hose and muffler assembly?
3. Why must the system be tested for leaks after recharging?
    a. To prevent further damage to the system
    b. To prevent loss of refrigerant oil
    c. To prevent loss of refrigerant
    d. All of the above
    e. None of the above.

Answers

1. c
2. To help prevent vibration and breakage of the metal lines of the assembly.
3. d

Practical Application:

R & R muffler hose assembly.

Method of Evaluation:

Use Checklist Performance Objective 41 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 41 EVALUATION

PERFORMANCE TEST FOR R & R MUFFLER HOSE ASSEMBLY

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Discharged system.		
2.	Loosened and removed muffler mounting bolts, brackets etc.		
3.	Loosened and disconnected muffler hose fittings at both ends.		
4.	Removed muffler hose assembly and O-rings from vehicle.		
5.	Lubricated new O-rings and installed on hose ends.		
6.	Lubricated hose connection threads and position assembly in original position.		
7.	Aligned and tightened fitting being careful not to strip or cross thread or cut or nick seals.		
8.	Reinstalled braces, brackets, bolts etc. securing assembly in vehicle.		
9.	Evacuated system.		
10.	Recharged and leak tested system.		
11.	Operated air conditioning and performance test system.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 42

TASK: R & R hose seals.

STANDARD OF PERFORMANCE OF TASK:

New seals are installed without cutting or kinking, hose connectors are tight with no stripped or crossed threads, and connections and O-rings must not leak.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Charging station
Refrigerant oil
O-rings

ENABLING OBJECTIVES:

1. Use charging station
2. Use standard tool kit

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 714-717.
2. **Air Conditioner Service Manual.**
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Have students read and discuss textbook, **Auto Mechanics: Theory and Service**, pp. 714-717.
2. Illustrate various types of hose seals.
3. Have the student identify several hose sealing methods.
4. Have the students read and list manufacturer's service procedure.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 42

CRITERION-REFERENCED MEASURE:

Questions

1. What purpose does an O-ring seal serve?
   a. Prevent loss of refrigerant oil
   b. Prevent loss of refrigerant
   c. Neither a or b
   d. Both a and b
2. Why must the new seal be lubricated with refrigerant oil before installation?
3. What could happen to the new seal if the hose connections were over tightened?

Answers

1. d
2. To help seat new seal and to prevent damage to seal.
3. The new seal could be damaged.

Practical Application:

R & R hose seals.

Method of Evaluation:

Use Checklist Performance Objective 42 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 42 EVALUATION

PERFORMANCE TEST FOR R & R HOSE SEALS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Determined which seals are leaking by using leak detector. (Add small amount of refrigerant to system if empty to produce a leak).		
2.	Cleaned connectors or seal area before disassembling.		
3.	Discharged system noting amount of oil lost, if any.		
4.	Loosened and disconnected hose connection at seal being replaced.		
5.	Removed old seal or O-ring.		
6.	Inspected sealing surfaces for nicks or cuts and corrected as necessary.		
7.	Lubricated new O-ring or seal with refrigerant oil.		
8.	Installed into recess or over end of connector, making sure it was fully seated.		
9.	Replaced any lost refrigerant oil previously noted.		
10.	Reattached hose connection and tightened securely.		
11.	Evacuated and recharged system and checked repair with leak tester.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

CHECKLIST FOR PERFORMANCE OBJECTIVE 42 EVALUATION

PERFORMANCE TEST FOR R & R HOSE SEALS

Student's Name ______________________ **Date** ______________

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Determined which seals are leaking by using leak detector. (Add small amount of refrigerant to system if empty to produce a leak).	______	______
2.	Cleaned connectors or seal area before disassembling.	______	______
3.	Discharged system noting amount of oil lost, if any.	______	______
4.	Loosened and disconnected hose connection at seal being replaced.	______	______
5.	Removed old seal or O-ring.	______	______
6.	Inspected sealing surfaces for nicks or cuts and corrected as necessary.	______	______
7.	Lubricated new O-ring or seal with refrigerant oil.	______	______
8.	Installed into recess or over end of connector, making sure it was fully seated.	______	______
9.	Replaced any lost refrigerant oil previously noted.	______	______
10.	Reattached hose connection and tightened securely.	______	______
11.	Evacuated and recharged system and checked repair with leak tester.	______	______

Approved: Yes ___ No ___

Evaluator's Signature ______________________ **Date** ______________

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 43

TASK: Clean and straighten condenser fins.

STANDARD OF PERFORMANCE OF TASK:

Any severely bent condenser fins which can cause air flow interruption must be straightened and any debris clogging condenser must be removed.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Compressed air
Water hose
Fin straightening tool

ENABLING OBJECTIVES:

1. Use compressed air
2. Use standard tool kit

RESOURCES:

1. **Air Conditioning Diagnosis,** Filmstrip M5J-AT-K-2A
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Show and discuss filmstrip, **Air Conditioning Diagnosis** M5J-AT-K-2A.
2. Explain the effect a dirty condenser would have on air conditioning performance.
3. Demonstrate the proper procedure of cleaning a dirty air conditioning condenser.
4. Demonstrate the proper procedure for straightening air condenser fins.
5. Compare the differences in air conditioner performance before and after cleaning and straightening condenser fins.

PERFORMANCE OBJECTIVE 43

CRITERION-REFERENCED MEASURE:

Questions:

1. Poor engine idle and driveability can be directly effected by:
   a. Insufficient cooling across the condenser and radiator,
   b. High-high side pressures in the air conditioner system,
   c. Both a and b,
   d. Neither a or b.
2. How could restricted condenser and radiator fins cause poor idle or driveability?
3. Inadequate air flow across the condenser will cause:
   a. Refrigerant temperature to rise,
   b. Refrigerant pressures to rise,
   c. All of the above,
   d. None of the above.

Answers

1. c
2. It would cause the compressor to labor (work harder) and put a greater load on the engine.
3. c

Practical Application:

Have students clean and straighten condenser fins.

Method of Evaluation:

Use Checklist Performance Objective 43 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 43 EVALUATION

PERFORMANCE TEST FOR CLEANING AND STRAIGHTENING CONDENSER FINS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Inspected condenser fins to determine degree of restriction.		
2.	Applied compressed air to surface of condenser or radiator facing engine to remove accumulated dirt and debris.		
3.	Applied spray of water in same manner if necessary.		
4.	Straightened bent or distorted condenser fins using appropriate tool.		
5.	Reinspected condenser to verify complete cleaning by shining light through fins.		
6.	Operated air conditioning to verify full air flow through condenser and radiator and checked performance to manufacturer's specifications.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 44

TASK: Test expansion valve.

STANDARD OF PERFORMANCE OF TASK:

An expansion valve which is blocked or closed at room temperature and which fails to close when the sensor is in ice water must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Ice water

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Follow manufacturer's procedure

RESOURCES:

1. Manufacturer's Service Manual.
2. **Air Conditioner Service Manual.**
3. **Basic Air Conditioning Systems,** Filmstrip MPI-8010.

TEACHING ACTIVITIES:

1. Show and discuss Filmstrip MPI-8010.
2. Explain the function of an internally equalized type expansion valve.
3. Explain the function of an externally equalized type expansion valve.
4. Have the student draw a diagram of each valve showing how it operates.
5. Have the students demonstrate the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 44

CRITERION-REFERENCED MEASURE:

Questions

1. What effect would a blocked inlet screen have on the expansion valve?
2. What effect could moisture have on the expansion valve?
3. During the winter months, what precautions could be taken to prevent damage to the expansion valve and other moving parts of the air conditioning system.

Answers

1. It could make the expansion valve test defective.
2. Moisture could cause corroding and sticking of the expansion valve.
3. Short periods of operation would help lubricate the entire system and help prevent damage of internal moving parts.

Practical Application:

Have students test an expansion valve.

Method of Evaluation:

Use Checklist Performance Objective 44 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 44 EVALUATION

PERFORMANCE TEST FOR TESTING EXPANSION VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Removed expansion valve.	______	______
2.	Checked inlet screen for dirt or blockage.	______	______
3.	Cleaned or replaced screen.	______	______
4.	Blew air through inlet of valve; air should pass through the valve at room temperature.	______	______
5.	Placed temperature sensing bulb or coil in ice water.	______	______
6.	Blew through the valve inlet; air should not pass through the valve with the sensor in ice water.	______	______
7.	Noted any defects in the expansion valve.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 45

TASK: R & R expansion valve and inlet screen.

STANDARD OF PERFORMANCE OF TASK:

New valve must be mounted securely, connection must be clean and tight and valve or connections must not leak.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Expansion valve and screen
Charging station
O-ring seals
Refrigerant oil

ENABLING OBJECTIVES:

1. Use charging station
2. Read diagrams and specific instructions
3. Identify expansion valve

RESOURCES:

1. Manufacturer's Service Manual.
2. **Air Conditioner Service Manual.**

TEACHING ACTIVITIES:

1. Have the students draw an expansion valve to illustrate refrigerant flow.
2. Explain safety measures.
3. Demonstrate the steps in task.
4. Draw a schematic of the manufacturer's repair procedure.
5. Have the students complete the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 45

CRITERION-REFERENCED MEASURE:

Questions

1. Why must system be evacuated before removing expansion valve?
    a. Because system is under high pressure
    b. Because refrigerant can cause severe injury
    c. Neither a nor b
    d. Both a and b.
2. What is the purpose of resealing expansion valve thermostatic bulb with insulation putty?
3. Why must a vacuum be pulled on the system before recharging?

Answers

1. d
2. Because the thermostat bulb is sensitive to temperature change and can cause the expansion valve to operate improperly.
3. To remove moisture and impurities from the system.

Practical Application:

Have students R & R expansion valve and inlet screen.

Method of Evaluation:

Use Checklist Performance Objective 45 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 45 EVALUATION

PERFORMANCE TEST FOR R & R EXPANSION VALVE AND INLET SCREEN

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Discharged air conditioning system.		
2.	Loosened insulation and mounted bracket for thermostatic bulb at evaporator.		
3.	Removed thermostatic bulb from evaporator.		
4.	Loosened and disconnected equalizer line at P.O.A. valve, if necessary.		
5.	Loosened and disconnected fittings at expansion valve.		
6.	Removed evaporator valve or inlet screen from vehicle and discarded O-rings.		
7.	Installed new valve and/or screen in place of original.		
8.	Lubricated new O-rings with refrigerant oil and installed at valve.		
9.	Installed and tightened refrigerant lines to valve being careful not to strip or over tighten nuts.		
10.	Reinstalled and tightened equalizer line at P.O.A. valve.		
11.	Positioned thermostatic bulb at original position at evaporator.		
12.	Reinstalled and tightened clamp or mounting bracket to evaporator and thermostatic bulb.		
13.	Resealed area with insulation putty.		
14.	Evacuated and recharged system.		
15.	Leak tested system and made performance check.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 46

TASK: Inspect evaporator housing drain.

STANDARD OF PERFORMANCE OF TASK:

Any condition(s) causing no or poor operation of case drain must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Read diagrams and specific instructions

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service** pp. 714, 715, 716.
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Have students review textbook, **Auto Mechanics: Theory and Service**, pp. 714, 715, 716.
2. Show the diagram of air conditioner evaporator housing, emphasize housing drain.
3. Explain the function of housing drain.
4. Show the difference in housing with and without drain hose.
5. Have the students draw housing showing drain location.
6. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 46

CRITERION-REFERENCED MEASURE:

Questions

1. What purpose does the evaporator housing drain serve?
2. The evaporator housing drain is:
   a. Located in the bottom half of the evaporator housing
   b. Sometimes made of a rubber drain hose
   c. Sometimes a simple hole
   d. All of the above
   e. None of the above.
3. A clogged evaporator housing drain could cause:
   a. Insufficient cooling
   b. Excessive water to drain back into the interior of the vehicle
   c. A stagnant smell through the vents of the vehicle
   d. All of the above.

Answers

1. It allows the excessive sweat or water to run off the evaporator and be routed to the exterior of the vehicle.
2. d
3. d

Practical Application:

Have students inspect evaporator housing drain.

Method of Evaluation:

Use Checklist Performance Objective 46 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 46 EVALUATION

PERFORMANCE TEST FOR INSPECTING EVAPORATOR HOUSING DRAIN

____

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to evaporator case drain.	________	________
2.	Operated air conditioning and watched for operation of drain.	________	________
3.	Inspected drain hose or outlet for obvious kinks or obstructions.	________	________
4.	Removed drain hose or outlet and checked for internal obstruction.	________	________
5.	Used shop light or flash light to inspect case drain hole for obstruction. (A blunt rod can be helpful to check for hidden obstruction).	________	________
6.	Reattached drain hose or outlet.	________	________

Approved: Yes ___ No ___

____

Student's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 47

TASK: Repair evaporator housing drain.

STANDARD OF PERFORMANCE OF TASK:

Repair evaporator housing drain.

SOURCE OF STANDARD:

Evaporator case must drain away accumulated water without excessive buildup or dripping into passenger section of vehicle.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Sealer or cement
Hose clamps

ENABLING OBJECTIVES:

1. Select proper tools
2. Use housing sealer or cement
3. Use hose clamps

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 714, 715, 716.
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Have students review textbook, **Auto Mechanics: Theory and Service**, pp. 714, 715, 716.
2. Show the diagram of air conditioner housing emphasizing evaporator housing drain.
3. Explain the function of housing drain.
4. Show the difference in housing with drain hose and without drain hose.
5. Have the students demonstrate the steps in the performance of the task identified in the performance evaluation.

PERFORMANCE OBJECTIVE 47

CRITERION-REFERENCED MEASURE:

Questions

1. When repairing or reopening an evaporator drain:
    a. A blunt instrument should be used
    b. Care should be taken not to damage the evaporator core or fins
    c. A and b
    d. Neither a or b.
2. To prevent a drain hose from coming loose you should use ____________.
3. A properly operating evaporator housing drain should:
    a. Permit water to run under vehicle only while air conditioning is operating,
    b. Permit water to run under vehicle at all times,
    c. Not permit water to run under vehicle at all,
    d. None of the above.

Answers

1. c
2. Cement or clamps
3. a

Practical Application:

Have students repair evaporator housing drain.

Method of Evaluation:

Use Checklist Performance Objective 47 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 47 EVALUATION

PERFORMANCE TEST FOR REPAIRING EVAPORATOR HOUSING DRAIN

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to evaporator case drain.		
2.	Inspected drain hose or outlet for obvious kinks or obstructions that prevented proper draining.		
3.	Removed drain hose and checked for obstructions.		
4.	Checked drain hole in case with flashlight or used a blunt ended rod or screwdriver to remove debris from drain hole, being careful not to damage evaporator or fins.		
5.	Reattached drain outlet or hose using cement or clamps if necessary to prevent it from coming loose.		
6.	Operated air conditioning system to verify correct drain operation.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 48

TASK: R & R evaporator pressure control valve.

STANDARD OF PERFORMANCE OF TASK:

Replacement valve must be installed in accordance with manufacturer's procedures.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS OF PERFORMANCE OF TASK:

Standard tool kit
Evaporator pressure control valve
Charging station
Refrigerant oil
Refrigerant

ENABLING OBJECTIVES:

1. Read diagrams and specific instructions
2. Use standard tool kit

RESOURCES:

1. **Air Conditioning Diagnosis,** Filmstrip M5J-AT-K-2A.
2. **Air Conditioning Service Manual.**
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Have students review and discuss, **Air Conditioning Diagnosis,** Filmstrip M5J-AT-K-2A.
2. Identify the location and explain the function of evaporator pressure regulator (EPR) valve.
3. Provide (EPR) valve for student to examine.
4. Emphasize manufacturer's usage of (EPR) valve.
5. Have the student list manufacturer's repair procedure.

PERFORMANCE OBJECTIVE 48

CRITERION-REFERENCED MEASURE:

Questions

1. The evaporator pressure regulator valve is calibrated to produce maximum cooling:
   a. Without causing frost or ice on the evaporator fins and tubing,
   b. While causing frost and ice to build up on the evaporator fins and tubing,
   c. Both a and b,
   d. Neither a or b.
2. What causes insufficient cooling on freeze up?
3. Checking the performance of a new valve after installation insures _______________.

Answers

1. a
2. Changing the factory calibration of the evaporator pressure regulator valve.
3. Maximum cooling without freeze up and no leaks.

Practical Application:

Have students R & R evaporator pressure control valve.

Method of Evaluation:

Use Checklist Performance Objective 48 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 48 EVALUATION

PERFORMANCE TEST FOR R & R EVAPORATOR PRESSURE CONTROL VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to control valve.	______	______
2.	Discharged A/C system.	______	______
3.	Loosened and removed brackets, bolts etc. securing valve in vehicle.	______	______
4.	Loosened and disconnected valve hoses and connections.	______	______
5.	Removed old valve from vehicle and discarded old O-rings.	______	______
6.	Lubricated new O-rings and threads with refrigerant oil and installed or attached new valve.	______	______
7.	Tightened hoses or lines at valve to manufacturer's specifications being careful not to strip or cross thread nuts or fittings.	______	______
8.	Reinstalled brackets, bolts, etc. securing valve to vehicle.	______	______
9.	Evacuated and recharged system.	______	______
10.	Leak tested system.	______	______
11.	Performance tested system to verify proper operations.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 49

TASK: R & R evaporator temperature control valve sensor.

STANDARD OF PERFORMANCE OF TASK:

Sensor must detect evaporator temperature and control same within manufacturer's tolerances and be mounted securely in place with no leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Evaporator temperature control sensor

ENABLING OBJECTIVES:

1. Read diagrams and specific instructions
2. Use standard tool kit

RESOURCES:

1. **Air Conditioning Diagnosis,** Filmstrip M5J-AT-K-2A.
2. **Air Conditioning Service Manual.**
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Have students review and discuss, **Air Conditioning Diagnosis,** Filmstrip M5J-AT-K-2A.
2. Identify the location and function of **Evaporator Temperature Regulator** (ETR) valve.
3. Provide (ETR) valve for students to examine.
4. Compare (ETR) valve to (EPR) valve and explain difference of each. Emphasize usage of each.
5. Have the students draw and be able to explain function of each valve.
6. Have the students explain why the (ETR) valve would have electrical connections.

PERFORMANCE OBJECTIVE 49

CRITERION-REFERENCED MEASURE:

Questions

1. Why is an (ETR) valve used in some air conditioning systems?
2. What type of air conditioning system uses this valve?
3. What shuts off flow of refrigerant from the compressor?

Answers

1. It helps to prevent icing of the evaporator.
2. Automatic temperature control units used on Chrysler vehicles.
3. The (ETR) valve.

Practical Application:

R & R evaporator temperature control valve sensor.

Method of Evaluation:

Use Checklist Performance Objective 49 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 49 EVALUATION

PERFORMANCE TEST FOR R & R EVAPORATOR TEMPERATURE CONTROL VALVE SENSOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to temperature control sensor.		
2.	Loosened and disconnected electrical connections.		
3.	Loosened and removed insulation and clamp on sensing line at evaporator.		
4.	Removed sensing line from evaporator.		
5.	Loosened and removed control mounting bolts or screws.		
6.	Removed control from vehicle.		
7.	Positioned new control in original position.		
8.	Installed and tightened mounting bolts or screws.		
9.	Inserted sensing line into evaporator at original position.		
10.	Reinstalled insulation to evaporator tube and sensing line.		
11.	Reinstalled insulation to evaporator tube and sensing line.		
12.	Reinstalled and tightened electrical connections.		
13.	Operated air conditioning system and checked proper performance of temperature control sensor.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 50

TASK: R & R system service valves.

STANDARD OF PERFORMANCE OF TASK:

Valves must control refrigerant and be securely mounted with no leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Charging station
Refrigerant oil
Service valves
Refrigerant

ENABLING OBJECTIVES:

1. Use charging station
2. Read diagrams and instructions
3. Use refrigerant safely

RESOURCES:

1. **Air Conditioning Service Manual.**
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Show the students a systems service valve.
2. Draw a system service valve showing various positions.
3. Explain the difference in a service valve and a Schrader valve.
4. Have the students draw a system service valve.
5. Have the students explain why it is called a 3 way valve; i.e., closed, service, open.
6. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 50

CRITERION-REFERENCED MEASURE:

Questions

1. What is one advantage of a three way system service valve?
2. Any system repair done with a __________ type system service valve would require system evacuate and recharge.
3. If a system service valve leaks, it should be:
   a. Replaced
   b. Repaired
   c. Both a and b
   d. Neither a or b.

Answers

1. The system can be shut off from compressor to permit compressor repairs without loosing systems charge.
2. Schrader.
3. a.

Practical Application:

R & R system service valve.

Method of Evaluation:

Use Checklist Performance Objective 50 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 50 EVALUATION

PERFORMANCE TEST FOR R & R SYSTEM SERVICE VALVES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Discharged system.	______	______
2.	Loosened and removed lines at service valve.	______	______
3.	Loosened and removed service valve mounting bolts or brackets.	______	______
4.	Removed and discarded old O-ring seals.	______	______
5.	Removed service valve.	______	______
6.	Lubricated new O-rings with refrigerant oil and installed on new service valve.	______	______
7.	Reinstalled new valve and installed and tightened mounting bolts, brackets etc.	______	______
8.	Reinstalled and tightened lines or fittings at valve being sure not to cut, nick, or kink seals.	______	______
9.	Evacuated and recharged system.	______	______
10.	Leak tested system and made performance check.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 51

TASK: R & R high pressure relief valve.

STANDARD OF PERFORMANCE OF TASK:

New valve must function to manufacturer's specifications for pressure release, must not leak and be securely mounted.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
High pressure relief valve and seal
Refrigerant oil
Charging station
Refrigerant

ENABLING OBJECTIVES:

1. Read diagrams and specific instructions
2. Identify O-ring seals
3. Use standard tool kit

RESOURCES:

1. **Air Conditioning Diagnosis,** PTF-9-85-10, pp. 6, 7.
2. **Air Conditioning Service Manual.**
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Have students read and discuss manual **Air Conditioning Diagnosis,** PTF-9-85-10, pp. 6, 7.
2. Show the location of high pressure relief valve on G.M., Ford, Chrysler, AMC, and other manufacturer's air conditioning units.
3. Explain the purpose and function of high pressure relief valve.
4. Have the students list the location of high pressure relief valve from five different manufacturers.
5. Have the students list the recommended repair procedure of manufacturer.

PERFORMANCE OBJECTIVE 51

CRITERION-REFERENCED MEASURE:

Questions

1. Discharge of air conditioner system is necessary before removal of high pressure relief valve because:
    a. System is under high pressure,
    b. Personal injury could result,
    c. Refrigerant must be safe to recharge system with same refrigerant,
    d. A and b only
    e. A, b, and c.
2. The high pressure relief valve will open and release refrigerant to atmosphere when:
    a. System pressure exceeds a preset level
    b. System temperature exceeds a preset level
    c. Neither a or b
    d. Both a and b.
3. After replacing a defective high pressure relief valve:
    a. Refrigerant level should be checked,
    b. Refrigerant level may not be checked,
    c. Refrigerant should be added,
    d. All of the above
    e. A and b only.

Answers

1. d
2. d
3. a

Practical Application:

Have students R & R high pressure relief valve.

Method of Evaluation:

Use Checklist Performance Objective 51 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 51 EVALUATION

PERFORMANCE TEST FOR R & R HIGH PRESSURE RELIEF VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to high pressure relief valve.	________	________
2.	Discharged air conditioning system.	________	________
3.	Removed bolts, snap rings etc, securing valve.	________	________
4.	Loosened and removed valve and seal if used.	________	________
5.	Lubricated new valve threads and seal and installed in original position being careful not to cross thread or damage seal.	________	________
6.	Reinstalled bolts, snap ring etc. if used to secure valve.	________	________
7.	Evacuated and recharged system.	________	________
8.	Leak tested system and checked system for proper operation.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 52

TASK: R & R P.O.A. valve.

STANDARD OF PERFORMANCE OF TASK:

Valve must provide for maximum cooling without causing condensation on evaporator from freezing within manufacturer's specified temperature range.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
P.O.A. valve
O-ring seals
Charging station
Refrigerant oil.

ENABLING OBJECTIVES:

1. Read diagrams and specific instructions.
2. Use charging station.
3. Identify P.O.A. valve.

RESOURCES:

1. Air Conditioning Service Manual.
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Define P.O.A. (Pilot Operated Absolute) valve.
2. Explain the function of P.O.A. valve.
3. Identify the location of P.O.A. valve.
4. Have the students draw and identify all parts of a P.O.A. valve.
5. Have students explain the main advantage of P.O.A. valves.
6. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 52

CRITERION-REFERENCED MEASURE:

Questions

1. The function of the P.O.A. valve is:
   a. To control evaporator pressure
   b. To control expansion valve pressure
   c. To control pressure of the compressor
   d. All of the above.
2. P.O.A stands for:
   a. Pressure operated absolute
   b. Pressure outside absolute
   c. Pilot operated absolute
   d. None of the above.
3. The P.O.A valve setting is factory set for 29.5 pounds per square inch gauge pressure, at 900 feet and:
   a. Is adjustable
   b. Is not to be tampered with
   c. Is self adjusting
   d. None of the above.

Answers

1. a
2. c
3. b

Practical Application:

Have students R & R P.O.A. valve.

Method of Evaluation:

Use Checklist Performance Objective 52 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 52 EVALUATION

PERFORMANCE TEST FOR R & R P.O.A. VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Discharged system.		
2.	Loosened and disconnected oil bleed fitting.		
3.	Loosened and disconnected equalizer fitting.		
4.	Loosened and disconnected inlet and outlet fittings.		
5.	Loosened P.O.A. valve to bracket clamp.		
6.	Removed P.O.A. valve and discarded O-rings.		
7.	Lubricated new O-rings with refrigerant oil.		
8.	Installed new O-rings and installed new valve in vehicle.		
9.	Installed and tightened P.O.A. valve to bracket clamp.		
10.	Connected and tightened inlet and outlet lines being careful not to cut.		
11.	Connected and tightened equalizer line.		
12.	Connected and tightened oil bleed fitting.		
13.	Evacuated and recharged system.		
14.	Leak tested system and made performance test.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 53

TASK: R & R V.I.R. valve.

STANDARD OF PERFORMANCE OF TASK:

Valve must provide maximum cooling without causing condensation on evaporator from freezing within manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
V.I.R. valve
O-rings
Charging station
Refrigerant oil

ENABLING OBJECTIVES:

1. Follow directions which are specific to the task
2. Use charging station

RESOURCES:

1. **Air Conditioning Service Manual.**
2. Manufacturer's Service Manual

TEACHING ACTIVITIES:

1. Provide a receiver dryer with a V.I.R. in place for demonstration.
2. Explain the function of VIR and usage by manufacturer.
3. Discuss the advantage of VIR control system.
4. Emphasize the service procedure of VIR system; (i.e.,) ease of replacing Desiccant bag.
5. Have the student list manufacturer's service procedure.
6. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 53

CRITERION-REFERENCED MEASURE:

Questions

1. Define V.I.R.
2. The V.I.R. system uses:
   a. A desiccant bag inside the assembly
   b. Has no type of desiccant
   c. Both a and b
   d. Neither a or b.
3. In the V.I.R. system what do the two valves function as?

Answers

1. Valve In Receiver.
2. a
3. One valve functions as the P.O.A. valve, the other valve functions as the expansion valve.

Practical Application:

Have students R & R V.I.R. valve.

Method of Evaluation:

Use Checklist Performance Objective 53 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 53 EVALUATION

PERFORMANCE TEST FOR R & R V.I.R. VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to V.I.R. valve.	____	____
2.	Discharged system.	____	____
3.	Removed caked dirt or grease from connections before disassembling fittings.	____	____
4.	Loosened and removed lines attached to V.I.R. valve.	____	____
5.	Loosened or removed clamp securing valve to mounting bracket.	____	____
6.	Removed valve from vehicle and discarded O-rings.	____	____
7.	Lubricated new O-rings and installed on lines or valve.	____	____
8.	Positioned new valve in original position.	____	____
9.	Added refrigerant oil to component in quantity and method prescribed by air conditioning system manufacturer.	____	____
10.	Installed and tightened V.I.R. mounting clamp to bracket bolts.	____	____
11.	Installed and tightened lines and fittings to V.I.R. valve, being careful not to strip or cross thread connectors.	____	____
12.	Evacuated and recharged system.	____	____
13.	Leak tested system and did performance test to verify correct operation.	____	____

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE AIR CONDITIONING SYSTEMS

PERFORMANCE OBJECTIVE 54

TASK: Charge system.

STANDARD OF PERFORMANCE OF TASK:

The high and low pressure readings must meet manufacturer's specifications considering ambient temperature.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Manifold Gauges and Hose
Vacuum Pump
Scale
Refrigerant
Specifications for system being charged

ENABLING OBJECTIVES:

1. Follow directions
2. Use manifold gauge set
4. Use vacuum pump
5. Use electronic sight glass

RESOURCES:

1. **Air Conditioning Service Manual.**
2. **Air Conditioning Diagnosis,** PTF-9-85-10.
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Review **Air Conditioning Diagnosis,** PTF-9-85-10, pp. 13, 14.
2. Explain the usage of performance chart, **Air Conditioning Diagnosis,** PTF-9-85-10 page 15.
3. Demonstrate the usage of manifold gauge set, vacuum pump and/or charging station, (Emphasize safety precautions).
4. Have the students list the steps in recharging system according to manufacturer's procedure.
5. Have the student demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 54

CRITERION-REFERENCED MEASURE:

Questions

1. All automotive air conditioning systems use only:
    a. R-22 refrigerant
    b. R-12 and R-22 mixture
    c. R-12 only
    d. None of the above.
2. When charging an air conditioner system, how do you know how much refrigerant the system will hold?
3. If the system does not have a sight glass, how do you know the system is fully charged?
4. What is the advantage of using an "Electronic Sight Glass?"

Answers

1. c
2. Read manufacturer's specifications.
3. Use an electronic sight glass or fill according to manufacturer's specifications.
4. It will let you know when the system is filled to capacity or if it is undercharged.

Practical Application:

Have students charge system.

Method of Evaluation:

Use Checklist Performance Objective 54 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 54 EVALUATION

PERFORMANCE TEST FOR CHARGING SYSTEM

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Attached manifold gauge to Schrader fittings or service valves.	______	______
2.	Purged or drained system.	______	______
3.	Evacuated system to remove any moisture.	______	______
4.	Inverted can or tank of refrigerant for liquid position.	______	______
5.	Purged filler line by loosening fitting at manifold gauges.	______	______
6.	Opened high (discharge) side of manifold gauge to check low pressure gauge for response.	______	______
7.	Closed gauge.	______	______
8.	Inverted can or tank for gas position.	______	______
9.	Started engine.	______	______
10.	Opened low pressure (suction) valve of the manifold gauge slowly to allow compressor to draw in gas until bubbles disappeared from sight glass or until the specified amount of refrigerant was obtained.	______	______
11.	Checked manifold gauges for pressures specified by manufacturer.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

DUTY: **MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS**

PERFORMANCE OBJECTIVE 55

TASK: R & R water control valve.

STANDARD OF PERFORMANCE OF TASK:

The valve must be installed according to manufacturer's specifications for direction of flow, and all fittings must be secure and free from leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement water control valve
Hose clamps

ENABLING OBJECTIVES:

1. Follow directions
2. Use standard tool kit
3. Use cooling system pressure tester

RESOURCES:

1. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Explain the operation of vacuum controlled water valve.
2. Explain the operation of manually controlled water valve.
3. Describe the location of various water valves.
4. Have the students draw and explain operation of vacuum controlled water valve and manually controlled water valve.
5. Have the students list the steps in replacement of various water control valves.
6. Have the student demonstrate the steps in the performance evaluation.

PERFORMANCE OBJECTIVE 55

CRITERION-REFERENCED MEASURE:

Questions

1. One of the main precautionary measures to be taken before removal of the water control valve is to:
    a. Allow cooling down of the hot coolant to prevent any injury
    b. Remove radiator cap to relieve pressure
    c. Both a and b
    d. Neither a or b.
2. After installation of the water control valve the engine should be run to normal operating temperature to:
    a. Insure that the water control valve is operating properly,
    b. Insure that the coolant system is full,
    c. Insure that the thermostat is opening and closing,
    d. All of the above
    e. None of the above.
3. If the water control valve is operating properly when closed:
    a. It should be hot on one side and cool on the other,
    b. It should be hot on both sides,
    c. Both a and b
    d. Neither a or b.

Answers

1. c
2. d
3. a

Practical Application:

Have students R & R water control valve.

Method of Evaluation:

Use Checklist Performance Objective 55 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 55 EVALUATION

PERFORMANCE TEST FOR R & R WATER CONTROL VALVE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the task within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located the water control valve.	______	______
2.	Removed necessary components to gain access.	______	______
3.	Drained coolant to below the level of the valve.	______	______
4.	Removed hose clamps at the valve.	______	______
5.	Removed the hoses from the valve.	______	______
6.	Removed control cable or vacuum hose.	______	______
7.	Removed valve mounting bolts.	______	______
8.	Removed valve.	______	______
9.	Installed new valve and attached securely.	______	______
10.	Connected the control cable or vacuum hose.	______	______
11.	Reattached hoses and secured clamps.		
12.	Replaced components removed for access.	______	______
13.	Replaced coolant.	______	______
14.	Started the engine and brought to normal operating temperature.	______	______
15.	Tested for valve operation by grasping the hose on either side of the valve and comparing temperature differences according to valve position.	______	______

Approved: Yes ____ No ____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 56

TASK: Test thermostat.

STANDARD OF PERFORMANCE OF TASK:

Any deviations from manufacturer's specifications for opening temperature must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Heating device
Pan of water
Thermometer

ENABLING OBJECTIVES:

1. Use thermometer
2. Read diagrams and specific instructions

RESOURCES:

1. **Cooling Systems** PT-6-81-3, pp. 3, 4.
2. **How to Service the Cooling System,** Filmstrip B-423.
3. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Lecture **Cooling Systems** PT-6-81-3, pp. 3, 4.
2. Show and discuss, **How to Service the Cooling System**, Filmstrip B-423.
3. Demonstrate the procedure for testing a thermostat.
4. Have the students draw two types of thermostats.
5. Have the students explain the function of the thermostat.
6. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 56

CRITERION-REFERENCED MEASURE:

Questions:

1. When testing a thermostat, and it opens early the thermostat:
    a. Should be adjusted
    b. Should be replaced
    c. Neither a or b
    d. Both a and b
2. The thermostat serves what purpose in the cooling system?
3. A thermostat that will not open could cause:
    a. Engine damage
    b. Engine to overheat
    c. Oil to thin out
    d. All of the above.
4. What effect would a cold thermostat have on engine performance?

Answers

1. b
2. Control engine temperature
3. d
4. Reduce fuel mileage
   Increase engine wear
   Increase exhaust emissions
   Affect driveability

Practical Application:

Have students test thermostat.

Method of Evaluation:

Use Checklist Performance Objective 56 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 56 EVALUATION

PERFORMANCE TEST FOR TESTING THERMOSTAT

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Placed thermostat in a pan of water with a thermometer.	________	________
2. Heated the water.	________	________
3. Observed thermostat operation and water temperature.	________	________
4. Compared with temperature specifications stamped on thermostat and with vehicle manufacturer's specifications.	________	________
5. Noted test results on work order.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: **MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS**

PERFORMANCE OBJECTIVE 57

TASK: R & R thermostat.

STANDARD OF PERFORMANCE OF TASK:

The thermostat must be installed according to manufacturer's specifications for placement and the hose connections and gasket must not leak.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement thermostat
Replacement gasket
Container for drained coolant
Gasket Sealer

ENABLING OBJECTIVES:

1. Read diagrams and specific instructions
2. Use gasket sealer
3. Use torque wrench

RESOURCES:

1. **How to Service the Cooling System,** Filmstrip B-423.
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Review filmstrip, **How to Service the Cooling System** B-423.
2. Discuss manufacturer's service procedure.
3. Explain safety precautions.
4. Have the student list the manufacturer's repair procedure.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 57

CRITERION-REFERENCED MEASURE:

Questions

1. Where is the thermostat located in the cooling system?
2. Why should you not overtighten the thermostat housing bolts?
3. What is the normal temperature of a thermostat in today's engines?

Answers

1. Between the engine and top radiator tank, usually in the intake manifold.
2. Overtighten could damage thermostat housing or gasket.
3. 195 degrees.

Practical Application:

Have students R & R thermostat.

Method of Evaluation

Use Checklist Performance Objective 57 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 57 EVALUATION

PERFORMANCE TEST FOR R & R THERMOSTAT

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located the thermostat.		
2.	Drained coolant to a level below that of the thermostat.		
3.	Removed any components necessary to gain access.		
4.	Removed hose clamp and hose.		
5.	Removed mounting bolts.		
6.	Removed thermostat housing and thermostat.		
7.	Cleaned mounting area and thermostat housing.		
8.	Seated thermostat.		
9.	Installed gasket and housing.		
10.	Installed thermostat housing and secured mounting bolts.		
11.	Replaced hose and hose clamps.		
12.	Replaced components removed for access.		
13.	Refilled coolant.		
14.	Started the engine and brought to normal operating temperature.		
15.	Checked for operation according to manufacturer's specified temperature and for leaks.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 58

TASK: R & R heater core (outside access).

STANDARD OF PERFORMANCE OF TASK:

The heater core must be installed in the position specified by manufacturer without leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Container for coolant
Replacement heater core
Sponge
Cooling system pressure tester

ENABLING OBJECTIVES:

1. Read diagrams and specific instructions
2. Use standard tool kit
3. Use cooling system pressure tester

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, p. 714.
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Lecture textbook, **Auto Mechanics: Theory and Service**, p. 714.
2. Describe the location of various heater cores.
3. Discuss the procedure for replacement of heater core on non air conditioner equipped vehicles and air conditioner equipped.
4. Explain the steps in replacing the heater core according to the manufacturer's specifications.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 58

CRITERION-REFERENCED MEASURE:

Questions

1. A leaking heater core will cause loss of:
   a. Oil
   b. Heater core fluid
   c. Engine coolant
   d. None of the above.
2. An outside accessible heater core can be pressure tested and will usually leak out:
   a. The top of the heater core housing
   b. The evaporator core drain
   c. The bottom of the heater core housing
   d. Will not show leakage anywhere
   e. B and c only.
3. When refilling a heating system after installing heater core the heater control should be in the ____________ position.

Answers

1. c
2. e
3. On

Practical Application:

Have students R & R heater core (outside access).

Method of Evaluation:

Use Checklist Performance Objective 58 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 58 EVALUATION

PERFORMANCE TEST FOR R & R HEATER CORE (OUTSIDE ACCESS)

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the task within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located heater core.		
2.	Drained coolant to a level below that of the heater core.		
3.	Removed components necessary for access.		
4.	Removed hoses and clamps.		
5.	Removed retaining plate or blower motor and air duct assembly.		
6.	Removed heater core mounting bolts and lifted core out.		
7.	Cleaned any spilled coolant from heater housing.		
8.	Installed new heater core and secured in place.		
9.	Replaced retaining plate or blower motor and air duct assembly.		
10.	Reattached hoses and clamps.		
11.	Replaced components removed for access.		
12.	Replaced coolant.		
13.	Started the engine and put temperature control lever on "hot."		
14.	Operated engine until the thermostat opened.		
15.	Turned off engine and topped off radiator coolant. (Caution: Removed radiator cap carefully to avoid hot coolant).		
16.	Pressure tested for leaks by running the engine at high RPMs.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 59

TASK: R & R heater core (inside access).

STANDARD OF PERFORMANCE OF TASK:

The heater core must be installed in the position specified by manufacturer without leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Container for coolant
Replacement heater core
Sponge
Drop cloth
Cooling system pressure tester

ENABLING OBJECTIVES:

1. Read diagrams and specific instructions
2. Use standard tool kit
3. Use cooiing system pressure tester

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, p. 714.
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Read and discuss textbook, **Auto Mechanics: Theory and Service**, p. 714.
2. Describe the location of various heater cores.
3. Discuss the procedure for replacement of heater core on air conditioner, and non air conditioner equipped vehicles.
4. Explain the steps in replacing the heater core according to the manufacturer's specifications.
5. Have the students demonstrate the steps in the performance of the task, identified in the performance evaluation.

PERFORMANCE OBJECTIVE 59

CRITERION-REFERENCED MEASURE:

Questions

1. In an inside accessible heater core, one sure sign of a leaking heater core could be __________.
2. Another sign of a leaking heater core (inside access) could be:
    a. A vapor coming from the air conditioner vents
    b. Loss of coolant with no visible signs
    c. A or b
    d. Neither a or b.
3. After installation of the heater core it:
    a. Should be pressure tested
    b. Should be checked for leaks
    c. Should be checked for proper operation
    d. All of the above.

Answers

1. Coolant present in the floor board of the passenger side of the vehicle.
2. c
3. d

Practical Application:

Have students R & R heater core (inside access).

Method of Evaluation:

Use Checklist Performance Objective 59 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 59 EVALUATION

PERFORMANCE TEST FOR R & R HEATER CORE (INSIDE ACCESS)

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located heater core.		
2.	Drained coolant to a level below that of the heater core.		
3.	Disconnected battery ground cable.		
4.	Installed a drop cloth on the car floor.		
5.	Removed components necessary for access.		
6.	Removed heater hoses and clamps.		
7.	Detached control cables or vacuum hoses.		
8.	Removed heater housing.		
9.	Removed retaining plate or dismantled housing, as required.		
10.	Removed heater core.		
11.	Cleaned accumulated coolant from heater housing.		
12.	Installed replacement heater core.		
13.	Replaced retaining plate or housing assembly.		
14.	Replaced heater housing.		
15.	Reattached control cable or vacuum hoses.		
16.	Replaced components removed for access.		
17.	Reattached battery ground cable.		
18.	Refilled coolant.		
19.	Started the engine and put temperature control lever on "hot."		
20.	Operated engine until the thermostat opens.		
21.	Turned off engine and topped off radiator coolant. (Caution: Removed radiator cap carefully to avoid hot coolant).		
22.	Pressure tested for leaks.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 60

TASK: R & R hoses.

STANDARD OF PERFORMANCE OF TASK:

Hoses must be routed according to manufacturer's specifications and must not leak when engine is at operating temperature and radiator pressure.

SOURCE OF STANDARD

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement hoses
Cooling system pressure tester

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Use cooling system pressure tester
3. Follow safety instructions

RESOURCES:

1. **Cooling System Service,** Filmstrip ATJ-5A.
2. Manufacturer's Service Manual.

TEACHING ACTIVITIES:

1. Show and discuss **Cooling System Service,** Filmstrip ATJ-5A.
2. Demonstrate the differences in hose conditions (use new and old hoses).
3. Demonstrate the safety precautions and steps in task.
4. Have the students explain manufacturer's service procedure.
5. Have the students complete the steps in the performance evaluation.

PERFORMANCE OBJECTIVE 60

CRITERION-REFERENCED MEASURE:

Questions

1. When replacing hoses, care should be taken:
    a. Not to overtighten clamps
    b. Not to kink twist hoses
    c. Not to undertighten clamps
    d. All of the above
    e. None of the above.
2. What percentage of antifreeze coolant should be used in most systems?
3. The lower radiator hose should have a spring inside it to prevent ____________________.

Answers

1. d
2. 50%
3. The hose from collapsing and reducing coolant flow.

Practical Application:

Have students R & R hoses.

Method of Evaluation:

Use Checklist Performance Objective 60 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 60 EVALUATION

PERFORMANCE TEST FOR R & R HOSES

Student's Name ______________________ **Date** __________

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Operated radiator petcock or removed lower radiator hose at radiator end of hose to drain antifreeze; if antifreeze was clean, saved it for reuse.	______	______
2.	Removed any obstructions necessary to gain access to hoses.	______	______
3.	Loosened or removed hose clamps and removed or cut hoses for outlet connections.	______	______
4.	Cleaned the water outlet connections with a wire brush or emery paper.	______	______
5.	Placed new hoses over outlet connections and route into positions specified by manufacturer.	______	______
6.	Tightened the hose clamps.	______	______
7.	Refilled the radiator with the proper coolant.	______	______
8.	Pressure tested the cooling system for leaks.	______	______
9.	Operated the engine to normal operating temperature to check that there were no leaks and that hoses were not rubbing on moving parts.	______	______

Approved: Yes ___ No ___

Evaluator's Signature ______________________ **Date** __________

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 61

TASK: Test thermal sensing switch.

STANDARD OF PERFORMANCE OF TASK:

All failures or malfunctions of thermal sensing switch must be detected and identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use multimeter
2. Read and interpret manufacturer's procedures

RESOURCES:

1. **Motor Auto Repair Manual**, p. 2-33 to 2-36.

TEACHING ACTIVITIES:

1. Describe the parts of the electric fan circuit.
2. Explain how the electric fan operates.
3. Discuss what operates the electric fan.
4. Explain how the thermal sensor and relay operate at the correct temperature.
5. Demonstrate how to diagnose problems in the system using a multimeter.

PERFORMANCE OBJECTIVE 61

CRITERION-REFERENCED MEASURE:

Questions

1. The __________ __________ is temperature sensitive.
2. The __________ __________ __________ sends voltage to the fan motor.
3. On G.M. automobiles, the fan motor will start running at ______________.

Answers

1. Thermal sensor
2. Cooling fan relay
3. 230°F

Practical Application:

Have students test thermal sensing switch.

Method of Evaluation:

Use Checklist Performance Objective 61 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 61 EVALUATION

PERFORMANCE TEST FOR TESTING THERMAL SENSING SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to thermal sensing switch. Inspected switch for loose or broken terminals or coolant leakage.		
2.	Tested switch operation when engine was below operating temperature.		
3.	Turned ignition on and probed 12 volts supply side of sensing switch to verify it was receiving current.		
4.	Checked and corrected as necessary if current was not being supplied.		
5.	Probed output terminal of switch with test light and replaced switch if it was completing electrical circuit below manufacturer's operating temperature.		
6.	Inserted thermometer into radiator coolant and operated engine.		
7.	Probed output terminal of switch, or noted operation of fan to verify correct operation of sensing switch.		
8.	Replaced sensing switch if it operated outside of manufacturer's specified temperature range or not at all.		

Approved: Yes___ No___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 62

TASK: R & R thermal sensing switch.

STANDARD OF PERFORMANCE OF TASK:

Switch must be securely mounted without being stripped or cross threaded; all electrical connections must be clean and tight and there must be no coolant leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Antifreeze drain pan
Thread sealant
Replacement thermal sensing switch
Cooling system pressure tester
Volt ohmmeter
Thermometer

ENABLING OBJECTIVES:

1. Use multimeter
2. Read and interpret manufacturer's procedures

RESOURCES:

1. **Chevrolet Shop Manual**, 1981, pp. 8A-81.

TEACHING ACTIVITIES:

1. Discuss causes of electric fan operation failures.
2. Demonstrate, using a wiring diagram, the electric fan circuit.
3. Describe problems that cause electric fan circuit failure.
4. Explain the circuit breaker used with the electric fan circuit.
5. Using an automobile, identify the electric fan components.

PERFORMANCE OBJECTIVE 62

CRITERION REFERENCED MEASURE:

Questions

1. The fan motor is controlled by the __________ __________.
2. The fan motor cuts off at __________.
3. The cooling fan uses a __________ fuse.

Answers:

1. Temperature switch
2. 201°F
3. 30 Amp.

Practical Application:

Have students R & R thermal sensing switch.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 62 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 62 EVALUATION

PERFORMANCE TEST FOR R & R THERMAL SENSING SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to thermal sensing switch.	______	______
2.	Loosened and removed electrical connections to switch.	______	______
3.	Drained coolant level below thermal sensing switch position to prevent coolant from escaping when switch removed.	______	______
4.	Loosened and removed switch.	______	______
5.	Applied thread sealant to new switch threads if being installed in coolant passage.	______	______
6.	Installed and tightened new switch in original position.	______	______
7.	Reconnected electrical wiring and tightened connections.	______	______
8.	Replaced coolant and pressure tested for leaks.	______	______
9.	Tested unit to verify specified operation and checked for coolant leaks around switch.	______	______
10.	Replaced any parts previously removed to gain access to thermal sensing switch.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 63

TASK: R & R drive belts.

STANDARD OF PERFORMANCE OF TASK:

Belts must be aligned and tensioned to manufacturer's specifications and attaching hardware must be fastened securely in place.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement belt
Belt tension gauge

ENABLING OBJECTIVES:

1. Read and interpret manufacturer's specifications
2. Use belt tension tester

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 159-160.
2. Stockel, et al., **Auto Mechanics Fundamentals**, pp. 83-84.

TEACHING ACTIVITIES:

1. Have students read page 83 in **Auto Mechanics Fundamentals.**
2. Explain the construction of V-belts and Ribbed belts.
3. Using old drive belts, show the student how to recognize a defective belt.
4. Demonstrate how to replace a defective drive belt.
5. Have a student replace a drive belt.

PERFORMANCE OBJECTIVE 63

CRITERION-REFERENCED MEASURE:

Questions

1. Two types of drive belts are __________ and __________.
2. A drive belt that becomes glazed will loose __________ and begin to slip.
3. After a new belt is installed, it is a good idea to check it's tension at about __________ miles of service.

Answers

1. V-Belts - Ribbed Belts
2. Friction
3. 200.

Practical Application:

Have students R & R drive belts.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 63 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 63 EVALUATION

PERFORMANCE TEST FOR R & R DRIVE BELTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located drive belt which required replacement.	______	______
2.	Loosened bolts and/or cap screws of alternator or other driven assembly which controls belt tension.	______	______
3.	Rolled the old belt off the pulleys or cut old belt.	______	______
4.	Placed new replacement belt around the drive pulleys.	______	______
5.	Pried with a bar against alternator or other appropriate driven assembly until belt was tightened.	______	______
6.	Tightened bolts of alternator or other assembly to hold tension on belt.	______	______
7.	Checked tension by pressing against belt to deflect it a specified distance or by other procedure specified by the manufacturer.	______	______
8.	Readjusted and rechecked if necessary.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 64

TASK: Test antifreeze.

STANDARD OF PERFORMANCE OF TASK:

Coolant freezing point must be noted and a freezing point or boiling point outside of the manufacturer's temperature specifications must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Antifreeze tester

ENABLING OBJECTIVES:

1. Use a coolant hydrometer
2. Demonstrate all safety precautions

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, p. 166.

TEACHING ACTIVITIES:

1. Have students read page 166 in **Auto Mechanics: Theory and Service.**
2. Demonstrate how to use the charts printed on antifreeze containers.
3. Have students list all safety precautions.
4. Demonstrate how to test coolant mixture.
5. Have student demonstrate how to test coolant mixture.

PERFORMANCE OBJECTIVE 64

CRITERION-REFERENCED MEASURE:

Questions

1. Coolant mixture should be changed every __________ years.
2. A coolant mixture of 50% water and 50% antifreeze will freeze at __________ degrees.
3. A __________ __________ measure the freezing point of the mixture of antifreeze water.

Answers

1. Two
2. -32°
3. Antifreeze hydrometer.

Practical Application:

Have students test antifreeze.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 64 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 64 EVALUATION

PERFORMANCE TEST FOR TESTING ANTIFREEZE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Operated the engine until it reaches normal temperature.	___	___
2.	Removed radiator cap slowly after shielding it with a rag to prevent burns, or removed coolant reservoir cap.	___	___
	(In some modern systems this may cause boiling and fluid discharge).	___	___
3.	Inserted antifreeze tester into the radiator.	___	___
4.	Drew antifreeze into tester until the float or balls rose.	___	___
5.	Read the antifreeze freezing point according to the tester instructions; compared with the freezing point requirement.	___	___
6.	Replaced the radiator cap.	___	___
7.	Noted test results on work order.	___	___

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 65

TASK: Clean cooling system chemically.

STANDARD OF PERFORMANCE OF TASK:

Any blockages or restrictions in the radiator, hoses, or engine water passages must be removed, and manufacturer's procedures must be followed.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

STANDARD OF PERFORMANCE OF TASK:

Standard tool kit
Chemical cleaning solution

ENABLING OBJECTIVES:

1. Read and interpret manufacturer's procedures
2. Select the proper chemical cleaner

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 166-167.

TEACHING ACTIVITIES:

1. Explain what happens in a cooling system when the coolant is not serviced.
2. Describe the different chemical cleaners.
3. List on the chalkboard all safety precautions.
4. Have students list all safety precautions in their notebooks.
5. Locate all petcocks and drain plugs that have to be removed on an automobile.

PERFORMANCE OBJECTIVE 65

CRITERION-REFERENCED MEASURE:

Questions

1. Heavy duty cooling system cleaners consist of __________ __________.
2. What is used to neutralize the acid in the cooling system cleaner?
3. What safety precaution **must** be followed when working with cooling system cleaners?

Answers

1. Phosphoric acid
2. Baking soda
3. Wear safety glasses.

Practical Application:

Have students clean cooling systems chemically.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 65 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 65 EVALUATION

PERFORMANCE TEST FOR CLEANING COOLING SYSTEM CHEMICALLY

Student's Name ______________________ **Date** ______________________

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Referred to the vehicle manufacturer's procedures and the instructions for the chemical cleaner.	______	______
2.	Drained the radiator by opening the petcock or removed the lower radiator hose; removed the engine block drain plugs if appropriate.	______	______
3.	Removed thermostat and replaced thermostat cap if required by manufacturer.	______	______
4.	Closed the drain cocks and plugs and refilled the system with clean water and the chemical cleaner. (Followed cautions given by the manufacturer).	______	______
5.	Ran the engine until it was hot with the heater controls "on."	______	______
6.	Drained the system and flushed with clean water until it ran clear.	______	______
7.	Cleaned the coolant recovery tank, if so equipped.	______	______
8.	Filled the engine with antifreeze and water solution per manufacturer's specifications.	______	______
9.	Operated the engine until it was at operating temperature.	______	______
10.	Checked for leaks and added additional coolant if necessary.	______	______

Approved: Yes ___ No ___

Evaluator's Signature ______________________ **Date** ______________________

DUTY: **MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS**

PERFORMANCE OBJECTIVE 66

TASK: Check variable speed fan clutch.

STANDARD OF PERFORMANCE OF TASK:

A clutch which slips at normal operating temperatures, must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Read and interpret manufacturer's procedure
2. Identify type of fan clutch

RESOURCES:

1. **Controlling Engine Temperature.**
2. **Chevrolet Engine and Cooling System,** (ST-342).
3. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 149-151.

TEACHING ACTIVITIES:

1. Have students read pages 149-151 in **Auto Mechanics: Theory and Service.**
2. Discuss why fan clutches are used on automobiles.
3. Explain the two types of fan clutches and how each operates.
4. Have a student identify the types of fan clutches.
5. Explain how to recognize a defective fan clutch.

PERFORMANCE OBJECTIVE 66

CRITERION-REFERENCED MEASURE:

Questions

1. What causes the thermostatic coil fan clutch to engage and pull air across the radiator?
2. Another name for the fluid fan drive is _______ _______ _______.
3. The fan clutch that transfers torque through the use of a special silicone is called a _______ _______ _______ _______.

Answers

1. Under hood temperatures
2. Torque control drive
3. Viscous drive fan clutch.

Practical Application:

Have students check variable speed fan clutch.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 66 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE 66 EVALUATION

PERFORMANCE TEST FOR CHECKING VARIABLE SPEED FAN CLUTCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Started the engine and ran until normal operating temperature was obtained.	________	________
2.	Increased the idle speed to approximately 1,000 RPM for at least five minutes.	________	________
3.	Stopped engine and immediately checked the effort required to turn the fan. (Protected hand with a glove or rag).	________	________
4.	Determined whether clutch is operating as intended by the effort required to turn fan; little effort indicated clutch was faulty.	________	________
5.	Noted any defects on work order.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 67

TASK: R & R variable speed fan clutch.

STANDARD OF PERFORMANCE OF TASK:

Clutch must be installed according to manufacturer's procedures and specifications for torque of the attaching bolts, and fan must not strike any parts of the engine compartment.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement clutch unit

ENABLING OBJECTIVES:

1. Use tool kit
2. Read and interpret manufacturer's specifications

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service.**

TEACHING ACTIVITIES:

1. Explain the purpose of the cooling fan.
2. List the types of fan clutches.
3. Explain the viscous drive fan clutch.
4. Discuss the bimetallic spring used in the viscous drive fan clutch.
5. Demonstrate the removal and installation of a fan clutch.
6. Have a student demonstrate the removal and installation of a fan clutch.

PERFORMANCE OBJECTIVE 67

CRITERION-REFERENCED MEASURE:

Questions

1. The __________ __________ regulates the flow of silicone in the fan clutch.
2. The fan clutch is __________ sensitive.
3. The liquid used in a fan clutch is ____________ ____________.

Answers

1. Bimetallic strip
2. Heat
3. Silicone oil.

Practical Application:

Have students R & R variable speed fan clutch.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 67 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 67 EVALUATION

PERFORMANCE TEST FOR R & R VARIABLE SPEED FAN CLUTCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Removed or pushed aside any obstructions.	______	______
2.	Loosened fan belt, if necessary for a particular model.	______	______
3.	Unbolted clutch and fan blade from water pump or water pump pulley as appropriate.	______	______
4.	Installed new clutch assembly to fan blade and secured the unit to the water pump or pulley.	______	______
5.	Checked variable speed fan clutch operation.	______	______
6.	Readjusted or replaced any components which were moved aside.	______	______

Approved: Yes ___ NO ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 68

TASK: R & R electric cooling fan motor.

STANDARD OF PERFORMANCE OF TASK:

Fan must be securely installed in the position specified by the manufacturer with all wire connections in place.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement fan motor

ENABLING OBJECTIVES:

1. Use multimeter
2. Read and interpret manufacturer's procedures

RESOURCES:

1. Forier. **Motor Auto Manual, 1982**, pp. 2-33 to 2-36.

TEACHING ACTIVITIES:

1. Explain why electric cooling fans are used on today's automobiles.
2. Have student list some of the automobiles that electric cooling fans are installed on.
3. Using an automobile so equipped, identify the related switches, relays, and wire connectors used by the manufacturer.
4. Discuss with the student the purpose of each switch, relay, and wire connector.
5. Demonstrate the correct diagnostic procedures to follow when troubleshooting the electric fan circuit.

PERFORMANCE OBJECTIVE 68

CRITERION-REFERENCED MEASURE:

Questions

1. The electric fan motor will operate any time the __________ __________ __________ is turned on.
2. The electric fan motor switch is ______________ __________.
3. To help prevent fuel vaporization on an automobile with extreme under hood temperatures, a __________ __________ is used and mounted on the carburetor.

Answers

1. Air conditioning compressor
2. Temperate sensitive
3. Delay relay.

Practical Application:

Have students R & R electric cooling fan motor.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 68 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 68 EVALUATION

PERFORMANCE TEST FOR R & R AN ELECTRIC COOLING FAN MOTOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Removed shrouding or other obstructing parts.		
2.	Unplugged the fan electrical connector.		
3.	Removed the attaching bolts and lifted out the fan motor unit.		
4.	Removed fan blades from old motor and mounted on replacement motor.		
5.	Placed the replacement motor into position.		
6.	Inserted and tightened the attaching bolts.		
7.	Plugged the electrical connections together.		
8.	Ran the engine to operating temperature to check the fan motor operation.		
9.	Replaced shrouding or other obstructing parts that were removed.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 69

TASK: Test radiator pressure cap.

STANDARD OF PERFORMANCE OF TASK:

Any difference between the rated pressure of the radiator cap and the actual pressure must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Radiator pressure tester

ENABLING OBJECTIVES:

1. Use radiator cap pressure tester
2. Read and interpret manufacturer's service manual

RESOURCES:

1. Toboldt, et al., **Automotive Encyclopedia,** pp. 115.
2. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 153-155.

TEACHING ACTIVITIES:

1. Describe the purpose of a radiator pressure cap.
2. Explain the two types of radiator caps.
3. Identify the parts of the closed cooling system radiator cap.
4. Explain the different cooling system problems the radiator cap can cause.
5. Describe how to check a radiator cap using the radiator cap pressure tester.

PERFORMANCE OBJECTIVE 69

CRITERION-REFERENCED MEASURE:

Questions

1. The boiling point of water is ________ degrees fahrenheit.
2. A current radiator cap of 15 psi will raise the boiling point of water to _______ degrees fahrenheit.
3. The closed cooling system water level should never be checked __________.

Answers

1. 212°
2. 260°
3. Hot

Practical Application:

Have students test radiator pressure cap.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 69 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 69 EVALUATION

PERFORMANCE TEST FOR TESTING RADIATOR PRESSURE CAP

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Removed radiator cap slowly after shielding it with a rag to prevent burns, or removed coolant reserving cap. (In some modern systems this may cause boiling and fluid discharge).	______	______
2.	Applied pressure on the cap by pumping up the pressure tester.	______	______
3.	Noted the pressure at which the cap's relief valve opens.	______	______
4.	Determined whether this pressure was the same as that stamped on the top of the radiator cap.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 70

TASK: Pressure test cooling system.

STANDARD OF PERFORMANCE OF TASK:

Any drop in the pressure of the cooling system must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Radiator pressure tester

ENABLING OBJECTIVES:

1. Use cooling system pressure tester
2. Read and interpret manufacturer's specifications

RESOURCES:

1. Toboldt, et al., **Automotive Encyclopedia,** pp. 113-115.
2. deKryger, et al., **Auto Mechanics: Theory and Service,** p. 148.

TEACHING ACTIVITIES:

1. Explain the purpose of a radiator.
2. Identify the two types of radiators.
3. Describe the tube type radiator core.
4. Describe the cellular type radiator core.
5. Have students explain the two types of radiator cores.

PERFORMANCE OBJECTIVE 70

CRITERION-REFERENCED MEASURE:

Questions

1. Most radiators are made of brass; aluminum, or ____________.
2. Which of the types of radiator is the strongest?
3. At which location does the coolant leave the radiator and go to the engine?

Answers

1. Cooper
2. Tube type
3. Lower radiator outlet.

Practical Application:

Have students pressure test cooling system.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 70 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 70 EVALUATION

PERFORMANCE TEST FOR PRESSURE TESTING COOLING SYSTEM

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Removed radiator cap slowly after shielding it with a rag to prevent burns, or removed coolant reserving cap. (In some modern systems this may cause boiling and fluid discharge).	________	________
2.	Attached radiator tester to filler.	________	________
3.	Applied specified pressure to cooling system with pressure tester.	________	________
4.	Checked all hoses, fittings, freeze plugs, and radiator for leaks.	________	________
5.	Noted any pressure drop which is observed on the tester.	________	________
6.	Released pressure tester and replaced radiator cap.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 71

TASK: R & R radiator.

STANDARD OF PERFORMANCE OF TASK:

Radiator must be installed securely in correct position according to manufacturer's procedures and hose connections must not leak.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement radiator
Antifreeze

ENABLING OBJECTIVES:

1. Use cooling system pressure tester
2. Read and interpret manufacturer's procedures

RESOURCES:

1. deKryger , et al., **Auto Mechanics: Theory and Service**, pp. 148-164.

TEACHING ACTIVITIES:

1. Explain the purpose of the radiator.
2. Discuss the down-flow and cross-flow radiator.
3. List the advantages of the cross-flow radiator.
4. Describe how the radiator dissipates heat.
5. Demonstrate the flow of coolant through the radiator.

PERFORMANCE OBJECTIVE 71

CRITERION-REFERENCED MEASURE:

Questions

1. The radiator tubes are made of ______________ or ______________ to conduct the heat from the coolant.
2. Two types of radiators are __________________________ and ____________________.
3. The radiator removes heat from the water by ________________________.

Answers

1. Copper - Aluminum
2. Down-flow - cross-flow
3. Convection

Practical Application:

Have students R & R radiator.

Method of Evaluating Practical Application:

Have students use Checklist Performance Objective 71 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 71 EVALUATION

PERFORMANCE TEST FOR R & R RADIATOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Drained cooling system by opening radiator petcock or removing lower radiator hose. (Use caution to avoid burns from hot coolant).	________	________
2.	Removed fan shroud or any other parts which may obstruct access.	________	________
3.	Disconnected hoses from radiator, including hoses for automatic transmission cooler; removed wires from any temperature sensors.	________	________
4.	Removed radiator mounting bolts and lifted radiator from vehicle.	________	________
5.	Installed replacement radiator in vehicle and secured with mounting bolts.	________	________
6.	Removed temperature sensors from old radiator and installed in replacement.	________	________
7.	Connected hoses and sensor wires to radiator.	________	________
8.	Replaced fan shroud and any other components which were removed.	________	________
9.	Refilled with antifreeze and ran engine to normal temperature.	________	________
10.	Pressure tested cooling system and topped off radiator if necessary.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 72

TASK: Inspect water pump.

STANDARD OF PERFORMANCE OF TASK:

Any leaks, worn seals or bearings, and other defects must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Mechanics stethoscope
Cooling system pressure tester

ENABLING OBJECTIVES:

1. Use cooling systems tester
2. Read and interpret manufacturer's procedure

RESOURCES:

1. Toboldt, et al., **Automotive Encyclopedia**, pp. 112-113.
2. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 148-152.

TEACHING ACTIVITIES:

1. Explain the purpose of a water pump.
2. List the types of water pumps.
3. Identify the parts of a centrifugal type water pump.
4. Describe how water pump operates.
5. Discuss with students how the coolant circulates through the cooling systems.

PERFORMANCE OBJECTIVE 72

CRITERION-REFERENCED MEASURE:

Questions

1. The most popular water pump is the __________ __________.
2. The __________ is used to circulate the coolant.
3. All water pumps use a __________ on the impeller shaft to prevent the coolant from leaking out of the cooling system.

Answers

1. Centrifugal type
2. Impeller
3. Seal

Practical Application:

Have students inspect water pump.

Method of Evaluating Practical Application:

Have students use Checklist Performance Objective 72 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 72 EVALUATION

PERFORMANCE TEST FOR INSPECTING A WATER PUMP

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Removed or put aside any components which blocked visual access to pump.		
2.	Examined pump shaft and gasket sealing areas for signs of leaking coolant.		
3.	Checked for loose bearings by grasping fan or pulley and feeling for excessive movement.		
4.	Ran engine and listened for noises in the water pump, using an engine stethoscope if necessary.		
5.	Replaced any interfering components which were removed or set aside.		
6.	Note any objects on work order.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: **MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS**

PERFORMANCE OBJECTIVE 73

TASK: R & R water pump.

STANDARD OF PERFORMANCE OF TASK:

Pump must be installed according to manufacturer's procedures and operate without leaks.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement water pump
Gasket(s)

ENABLING OBJECTIVES:

1. Use cooling system pressure tester
2. Read and interpret manufacturer's procedures

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 148, 164, 167.

TEACHING ACTIVITIES:

1. Discuss the purpose of the cooling system.
2. Explain how the water pump operates.
3. Describe how the water pump is constructed.
4. Demonstrate how to test for a defective water pump.
5. Have a student demonstrate how to test for a defective water pump.

PERFORMANCE OBJECTIVE 73

CRITERION REFERENCED MEASURE:

Questions

1. A water pump is driven by the __________ __________.
2. The __________ in the water pump circulates the coolant through the engine.
3. A __________ __________ __________ is used to determine if a seal is leaking in the water pump.

Answers

1. V-type fan belt
2. Impeller
3. Coolant pressure tester

Practical Application:

Have students R & R water pump.

Method of Evaluating Practical Application:

Have students use Checklist Performance Objective 73 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 73 EVALUATION

PERFORMANCE TEST FOR R & R WATER PUMP

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Drained the cooling system. (Used caution to avoid burns from hot coolant).	________	________
2.	Removed the fan shroud, fan belts, and other interfering parts.	________	________
3.	Removed all hoses from water pump.	________	________
4.	Unbolted water pump and removed from engine, along with old gasket(s).	________	________
5.	Scraped any old gasket material and other dirt from pump mounting surface on engine, taking care that material does not go into water passages.	________	________
6.	Placed the new pump and gasket in their proper positions, used sealer on the gasket if specified by the manufacturer.	________	________
7.	Bolted the new pump in place, using sealer on the bolt threads if specified by the manufacturer.	________	________
8.	Reattached hoses and belts, and replaced fan shroud and other interfering parts which may have been removed.	________	________
9.	Refilled the cooling system and ran the engine with the heater control "on" until thermostat opened.	________	________
10.	Checked for leaks and rechecked the coolant level.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 74

TASK: R & R freeze plugs.

STANDARD OF PERFORMANCE OF TASK:

Freeze plugs must be installed in accordance with manufacturer's procedures and must not leak.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement freeze plugs
Freeze plug removal tool
Cooling system pressure tester

ENABLING OBJECTIVES:

1. Use coolant system pressure tester
2. Read and interpret manufacturer's service manual

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, p. 151.
2. Stockel, et al., **Auto Mechanics: Fundamentals**, p. 82.

TEACHING ACTIVITIES:

1. Discuss engine block construction and water jackets.
2. Explain why freeze plugs are used in engines.
3. Describe the different types of freeze plugs.
4. Using an engine assembly, identify where the freeze plugs are located.
5. Explain what causes freeze plugs to start leaking.

PERFORMANCE OBJECTIVE 74

CRITERION-REFERENCED MEASURE:

Questions

1. What is the hollow passage in the block and cylinder heads called?
2. Freeze plugs used in engines are made of ____________.
3. Freeze plugs are located in the ____________ ____________.

Answers

1. Water Jackets
2. Steel
3. Cylinder block.

Practical Application:

Have students R & R freeze plugs.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 74 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 74 EVALUATION

PERFORMANCE TEST FOR R & R FREEZE PLUGS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Drained radiator and engine block by opening petcocks and removing threaded plugs in engine block.		
2.	Removed the freeze plug from engine block using the specified tool.		
3.	Cleaned the plug opening in the engine block.		
4.	Applied sealer to replacement plug if specified by manufacturer.		
5.	Installed replacement freeze plug using the specified tool.		
6.	Filled the cooling system to the proper level.		
7.	Ran the engine to a normal temperature and checked for leaks, or carried out a pressure test of the system.		
8.	Rechecked the coolant level.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OBJECTIVE 75

TASK: Test cold lockout switch.

STANDARD OF PERFORMANCE OF TASK:

All failures or malfunctions of cold lockout switch must be detected and identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:
Standard tool kit.

ENABLING OBJECTIVES:

1. Recognize various types of coolant switches.
2. Operate the ohmmeter properly.
3. Use the thermometer correctly.

RESOURCES:

1. **Complete Car Care Manual.**

TEACHING ACTIVITIES

1. Demonstrate proper connection between lockout switch and ohmmeter.
2. Discuss and determine proper battery voltage at lockout switch terminal.
3. Explain why the ohmmeter reads either infinity or zero, depending on condition of lockout switch.
4. Show condition of lockout switch under cold and warm engine temperature.
5. Tell why loose/broken terminals cause intermittent operation.
6. Have the students determine if switch meets manufacturer's specifications.

PERFORMANCE OBJECTIVE 75

CRITERION-REFERENCED MEASURE:

Questions

1. Test a two terminal switch by touching ____________ probes to each terminal.
2. Suspend the switch in a pan of water so that only the __________ is immersed.
3. The ___________ is used to measure water temperature while testing the lockout switch.

Answers

1. Ohmmeter
2. Sensor
3. Thermometer

Practical Application:

Have students test cold lockout switch.

Method of Evaluation:

Use Checklist Performance Objective 75 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 75 EVALUATION

PERFORMANCE TEST FOR TESTING COLD LOCKOUT SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to electrical connections at cold lockout switch.	______	______
2.	Ground tested light lead and activated blower motor circuit.	______	______
3.	Probed hot terminal of switch to verify that switch is receiving battery voltage.	______	______
4.	Determined cause of no voltage if test light does not light.	______	______
5.	Probed outlet terminal of switch.	______	______
6.	Warmed engine if necessary to bring switch up to operational temperature.	______	______
7.	Replaced switch if test light did not come on at specified activating temperature.		
8.	Checked switch also below specified activating temperature to make sure it's not shorted.	______	______
9.	Replaced switch if it did not meet manufacturer's specifications or if there were loose/broken terminals causing intermittent operation.	______	______

Approved Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE COOLING AND HEATING SYSTEMS

PERFORMANCE OF OBJECTIVE NO. 76

TASK: R & R cold lockout switch.

STANDARD OF PERFORMANCE OF TASK:

Switch must be securely mounted without being stripped or cross threaded; all electrical connections must be clean and tight, there must be no coolant leaks, and switch must control blower motor operation at manufacturer's specified temperatures.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Antifreeze drain pan
Thread sealant
Replacement cold lockout switch.

ENABLING OBJECTIVES:

1. Recognize correct type lockout switch.
2. Use standard hand tools. Follow directions.
3. Check coolant strength. Test switch for correct operation.

RESOURCES:

1. Reader's Digest, **Complete Car Care Manual,** Pleasantville, New York/Montreal, 1981.

TEACHING ACTIVITIES:

1. Have the students drain the coolant to below the level of the switch.
2. Have the students remove all electrical wires from lockout switch.
3. Have the students remove the switch by unscrewing it.
4. Direct students to apply tread sealant to new switch before installing.
5. Instruct students to tighten new switch securely and check switch for coolant leaks.

PERFORMANCE OF OBJECTIVE NO. 76

CRITERION-REFERENCED MEASURE:

Questions

1. The threads of the new lockout switch should be coated with a _______________ or _______________ to prevent leakage.
2. The water temperature should near _______________ when testing the new switch.
3. Electrical lockout switches have either one or two ______________.

Answers

1. Sealer or tape (Teflon)
2. 212°F or 100°C
3. Terminals

Practical Application:

Have student remove and replace cold lockout switch.

Method of Evaluation:

Use Checklist Performance Objective 76 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 76 EVALUATION

PERFORMANCE TEST FOR R & R LOCKOUT SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to cold lockout switch.		
2.	Loosened and removed electrical connections to switch.		
3.	Drained coolant level below cold lockout switch position to prevent coolant from escaping when switch removed.		
4.	Loosened and removed switch.		
5.	Applied thread sealant to new switch threads if being installed in coolant passage.		
6.	Installed and tightened new switch in original's position.		
7.	Reconnected electrical wiring and tightened connections.		
8.	Replaced coolant.		
9.	Tested unit to verify specified operation and checked for coolant leaks around switch.		
10.	Replaced any parts previously removed to gain access to cold lockout switch.		

Approved: Yes ____ No ____

Evaluator's Signature **Date**

MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 77

TASK: R & R electrical control switches.

STANDARD OF PERFORMANCE OF TASK:

New switch must be securely mounted, all electrical connections must be tight; switch must operate and function as original with no arcing or short circuits, and switch must be adjusted, if required, to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement control switches.

ENABLING OBJECTIVES:

1. Use a multimeter.
2. Read and interpret manufacturer's service manual.

RESOURCES:

1. deKryger, et al. **Auto Mechanics: Theory and Service**, pp. 276-277, 280.

TEACHING ACTIVITIES:

1. Describe an electrical circuit and conductors.
2. Explain how an electrical switch operates.
3. Demonstrate using a schematic drawing, how to identify parts of an electrical circuit.
4. Discuss what affects an open circuit, close circuit, short circuit, and grounded circuit can have on current flow.
5. Have student demonstrate how to read a schematic drawing.

PERFORMANCE OBJECTIVE 77

CRITERION-REFERENCED MEASURE:

Questions

1. A ____________ can be used to complete or open a circuit.
2. A special drawing used to indicate electrical circuits is called a __________ ________.
3. When a conductor accidentally touches another conductor causing a different flow of electricity it is called a __________ __________.

Answers

1. Switch
2. Schematic Drawing
3. Short circuit.

Practical Application:

Have students R & R electrical control switches.

Method of Evaluating Practical Application:

Have students Use Checklist Performance Objective 77 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 77 EVALUATION

PERFORMANCE TEST FOR R & R ELECTRICAL CONTROL SWITCHES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Disconnected battery.		
2.	Located and gained access to switch.		
3.	Removed any trim or body components interfering with removal of switch.		
4.	Deactivated electrical circuit in which switch operates.		
5.	Loosened and removed electrical connections to switch.		
6.	Loosened and removed bolts, screws, nuts securing switch to vehicle.		
7.	Removed switch from vehicle.		
8.	Installed new switch in original's position.		
9.	Reinstalled bolts, screws, nuts securing switch.		
10.	Reattached electrical connections.		
11.	Reactivated electrical circuit in which switch operates.		
12.	Tested and/or adjusted switch referring to vehicle manufacturer's specifications if necessary.		
13.	Reinstalled any trim or parts previously removed to join access to switch.		
14.	Reconnected battery.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: **MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS**

PERFORMANCE OBJECTIVE 78

TASK: Test relays.

STANDARD OF PERFORMANCE OF TASK:

All failures and malfunctions of relays must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Vehicle manufacturer's electrical diagrams
Ohmmeter
12 volt electrical source

ENABLING OBJECTIVES:

1. Use an ohmmeter
2. Read and interpret manufacturer's specifications

RESOURCES:

1. Stockel, et al., **Auto Mechanics Fundamentals,** pp. 505-506, 511.
2. deKryger, et al. **Auto Mechanics: Theory and Service,** pp. 301, 332- 334, 384.

TEACHING ACTIVITIES:

1. Have student read pp. 310, 332-334, and 384 in **Auto Mechanics: Theory and Service.**
2. Explain how a relay operates using electricity.
3. Sketch on chalkboard how an electromagnet operates.
4. Describe the different types of relays.
5. Demonstrate how to test relays.

PERFORMANCE OBJECTIVE 78

CRITERION-REFERENCED MEASURE:

Questions

1. An electromagnetic device used to make and break a circuit is called a ____________.
2. A relay that limits the amount of current flow in the charging system is the ____________ ____________.
3. The starting system uses a relay known as a ____________.

Answers

1. Relay
2. Voltage regulator
3. Solenoid.

Practical Application:

Have students test relays.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 78 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 78 EVALUATION

PERFORMANCE TEST FOR TESTING RELAYS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Obtained manufacturer's electrical diagrams if necessary to determine relay function/operation.	________	________
2.	Determined connection on relay which attached to 12 volt source will activate magnetic coil.	________	________
3.	Inspected for loose or broken wires, rusty/corroded terminals or contacts.	________	________
4.	Inspected contact points for excessive pitting or burned surfaces.	________	________
5.	Applied 12 volts source to coil to determine if solenoid was operating.	________	________
6.	Attached ohmmeter leads to each pair of contacts and noted readings while operating relay coil.	________	________
7.	Determined if contacts function as manufacturer specifies.	________	________
8.	Noted test results on work order.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 79

TASK: R & R relay.

STANDARD OF PERFORMANCE OF TASK:

New relays must be securely mounted and all electrical connections must be clean and tight and function as specified by manufacturer.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
New relay

ENABLING OBJECTIVES:

1. Use multimeters
2. Read and interpret manufacturer's specifications

RESOURCES:

1. deKryger, et al. **Auto Mechanics: Theory and Service**, pp. 332-334.

TEACHING ACTIVITIES:

1. List the parts of a relay.
2. Explain how a electromagnetic force is used in a relay.
3. Discuss the operation of a relay.
4. Explain why relays are used on automobiles.
5. List the different relays used on automobiles.

PERFORMANCE OBJECTIVE 79

CRITERION-REFERENCED MEASURE:

Questions

1. A relay uses ________ ________ to operate contact points.
2. The magnetic force is created in the ________.
3. An example of a relay is a __________ __________.

Answers

1. Electromagnetic force
2. Coil
3. Starter solenoid.

Practical Application:

Have students R & R a relay.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 79 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 79 EVALUATION

PERFORMANCE TEST FOR R & R RELAY

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to relay.		
2.	Removed any trim or body components interfering with removal of relay.		
3.	Deactivated electrical circuit in which relay operates.		
4.	Loosened and removed electrical connections to relay.		
5.	Loosened and removed bolts, screws, nuts securing relay to vehicle.		
6.	Removed relay from vehicle.		
7.	Installed new relay in original position.		
8.	Reinstalled bolts, screws, nuts securing relay.		
9.	Reattached electrical connections.		
10.	Reactivated electrical circuit in which relay operates.		
11.	Tested relay to see if it conforms to manufacturer's specifications.		
12.	Reinstalled any trim or parts previously removed to gain access to relay.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 80

TASK: Test blower motor resistors.

STANDARD OF PERFORMANCE OF TASK:

Any broken, shorted or malfunctioning resistors must be detected.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Ammeter
Voltmeter

ENABLING OBJECTIVES:

1. Use multimeter
2. Read and interpret manufacturer's specifications

RESOURCES:

1. deKryger, et al., **Automotive Mechanics: Theory and Service.**

TEACHING ACTIVITIES:

1. Explain the purpose of a blower motor resistor.
2. Describe the construction of a blower motor resistor.
3. Illustrate how the blower motor resistor controls voltage output to the blower motor to control blower speeds.
4. Demonstrate how to use a multimeter to determine the resistance in the blower motor resistor.
5. Have a student demonstrate how to check a resistor using a multimeter.

PERFORMANCE OBJECTIVE 80

CRITERION-REFERENCED MEASURE:

Questions

1. A ____________ lowers the amount of voltage in a circuit.
2. The blower motor resistor controls ___________ blower speeds.
3. The ____________ ___________ sends voltage to the resistor.

Answers

1. Resistor
2. Three
3. Blower switch

Practical Application:

Have students test blower motor resistors.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 80 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 80 EVALUATION

PERFORMANCE TEST FOR TESTING BLOWER MOTOR RESISTORS.

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to blower motor resistor.	________	________
2.	Activated resistor circuit and checked for supply current to resistor voltmeter.	________	________
3.	Probed resistor output terminals, noted voltages and compared to manufacturer's specifications.	________	________
4.	Deactivated circuit.	________	________
5.	Disconnected electrical connections.	________	________
6.	Tested resistor with ohmmeter per manufacturer's instructions.	________	________
7.	Attached ammeter in series with blower motor power feed and compared draw with manufacturer's specifications to determine if defective blower motor overloaded blower motor resistor.	________	________
8.	Noted test results on work order.	________	________

Approved: Yes ____ No ____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 81

TASK: R & R blower motor resistors.

STANDARD OF PERFORMANCE OF TASK:

New resistors must be securely mounted and all electrical connections must be clean and tight.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
New resistors

ENABLING OBJECTIVES:

1. Use a multimeter
2. Read and interpret Manufacturer's Service Manual

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 281, 282, 136.

TEACHING ACTIVITIES:

1. Explain ampere, ohm, and volt.
2. Demonstrate to students how to use a multimeter to read ampere, ohm, and volt.
3. Have students demonstrate how to use a multimeter.
4. Sketch on chalkboard the blower motor wiring circuit.
5. Discuss how the blower motor resistor changes the fan speed by changing resistance.

PERFORMANCE OBJECTIVE 81

CRITERION-REFERENCED MEASURE:

Questions:

1. Resistance is measured in ______________.
2. Electrical pressure necessary to make one ampere of electricity flow through one ohm of resistance is called ______________.
3. The measurement of electrical current passing a point in one second is called ______________.

Answers

1. Ohms
2. Volts
3. Amperes

Practical Application:

Have students R & R blower motor resistors.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 81 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 81 EVALUATION

PERFORMANCE TEST FOR R & R BLOWER MOTOR RESISTORS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to resistors.		
2.	Removed any parts interfering with removal of resistors.		
3.	Deactivated electrical circuit in which resistor operates.		
4.	Loosened and removed electrical connections to resistor.		
5.	Loosened and removed bolts, screws, nuts securing resistor to vehicle.		
6.	Removed resistor from vehicle.		
7.	Installed new resistor in original position.		
8.	Reinstalled bolts, screws, nuts securing resistor.		
9.	Reattached electrical connections.		
10.	Reactivated electrical circuit in which resistor operates.		
11.	Tested resistor to see if it conforms to manufacturer's specifications.		
12.	Reinstalled any parts previously removed to gain access to resistors.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 82

TASK: Test connectors and wires of electrical circuits.

STANDARD OF PERFORMANCE OF TASK:

All high resistance connections, shorted, open and out of tolerance wiring must be detected and any broken or deteriorated parts must be noted.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

STANDARD OF PERFORMANCE OF TASK:

Standard tool kit
Volt ohmmeter

ENABLING OBJECTIVES:

1. Use multimeter
2. Use circuit tester

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service**, pp. 380-384.

TEACHING ACTIVITIES:

1. Explain a wiring harness.
2. Discuss a printed circuit.
3. Demonstrate how to use a wiring diagram.
4. Have a student demonstrate how to use a wiring diagram.
5. Explain the different types of circuit protection units used on today's automobiles.

PERFORMANCE OBJECTIVE 82

CRITERION-REFERENCED MEASURE:

Questions

1. A bundle of wires grouped together is called a ________________.
2. A drawing similar to a road map is a ___________ ___________.
3. A thin sheet of nonconductive plastic material on which conductive metal is placed is called a _____________ _____________.

Answers

1. Harness
2. Wiring diagram
3. Printed circuit.

Practical Application:

Have students test connectors and wires of electrical circuits.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 82 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 82 EVALUATION

PERFORMANCE TEST FOR TESTING CONNECTORS AND WIRES OF ELECTRICAL CIRCUITS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to electrical circuit being checked.		
2.	Activated circuit and ground tested light lead.		
3.	Probed connectors and wire of circuit starting at termination and worked back toward origination.		
4.	Tested both sides of each connector to locate any failed or poor connections.		
5.	Inspected wiring and connectors for shorts, corrosion or bare spots; repaired if necessary.		
6.	Noted test results on work order.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: **MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS**

PERFORMANCE OBJECTIVE 83

TASK: R & R connectors and wires of electrical circuits.

STANDARD OF PERFORMANCE OF TASK:

All connections must be clean and tight and all wires must be routed or secured to prevent contact with moving parts or excessive heat.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement connector and wires
Soldering gun and solder

ENABLING OBJECTIVES:

1. Use tool kit
2. Read and interpret standard procedure

RESOURCES:

1. **Oldsmobile Service Manual,** 1980.

TEACHING ACTIVITIES:

1. Explain a wiring diagram.
2. Describe ways a wire can be damaged in a circuit.
3. Explain fuses, circuit breakers, and fuseable links.
4. Demonstrate the proper way to repair wiring.
5. Have student demonstrate the proper way to repair wiring.

PERFORMANCE OBJECTIVE 83

CRITERION-REFERENCED MEASURE:

Questions

1. The drawing of a wiring circuit is called a ________ ________.
2. The ________ ________ contains the protective fuses in nearly all automobile circuits.
3. The ________ ________ used on G.M. automobiles is located near the starter.

Answers

1. Wiring diagram
2. Fuse block
3. Fuseable link

Practical Application:

Have students R & R connectors and wires of electrical circuits.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 83 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 83 EVALUATION

PERFORMANCE TEST FOR R & R CONNECTORS AND WIRES OF ELECTRICAL CIRCUITS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the task within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to connector or wiring being replaced.		
2.	Deactivated electrical circuits.		
3.	Cut and removed defective connector or wiring using diagonal cutting pliers or equivalent.		
4.	Selected a suitable replacement connector or terminal.		
5.	Stripped ends of wire previously attached to connector.		
6.	Attached connector or terminal by soldering or crimping.		
7.	Selected new piece of wire of same or heavier gauge as original of sufficient length for repairing circuit.		
8.	Removed insulation from ends of wire.		
9.	Connected or attached wire to circuit with both connectors or by soldering.		
10.	Taped any bare connections.		
11.	Secured new wires for connectors similar to originals to prevent contact with moving parts or other interference with operation of vehicle.		
12.	Reattached electrical connections.		
13.	Reactivated electrical circuits and verified correct operation.		
14.	Replaced any parts previously removed to gain access to connectors or wiring.		

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 84

TASK: Adjust air conditioning and heater control cables.

STANDARD OF PERFORMANCE OF TASK:

Cables must be adjusted to obtain full and sufficient travel of component being operated without excessive free play. Kinking or binding of cables while in operation must be corrected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit

ENABLING OBJECTIVES:

1. Use standard tool kit
2. Read and interpret manufacturer's procedures

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 721-723.

TEACHING ACTIVITIES:

1. Explain the parts of the heater control assembly.
2. Discuss the defroster cable.
3. Discuss the outside air cable.
4. Explain the blend air cable.
5. Demonstrate how to adjust each cable.

PERFORMANCE OBJECTIVE 84

CRITERION-REFERENCED MEASURE:

Questions

1. The heater/A/C control assembly is located in the __________ of an automobile.
2. The _______ ______ ______ allows fresh air to enter the automobile.
3. The ___________ ___________ directs air to the windshield.

Answers

1. Dash
2. Outside air cable
3. Defroster cable

Practical Application:

Have students adjust air conditioning and heater control cables.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 84 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 84 EVALUATION

PERFORMANCE TEST FOR ADJUSTING AIR CONDITIONING HEATER CONTROL CABLES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to cables and components being controlled by cables.	________	________
2.	Operated heater or air conditioning control and observed movement of the component being controlled.	________	________
3.	Noted movement, if any, and compared with manufacturer's specifications.	________	________
4.	Loosened cable adjusting clamp and move cable backwards or forwards to obtain full travel of component.	________	________
5.	Checked routing of cables and adjusted as necessary to remove excessive play when operated or binding of controls from kinked or pinched cables.	________	________
6.	Reinstalled all parts previously to gain access to cables.	________	________

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 85

TASK: R & R air conditioning and heater control cables.

STANDARD OF PERFORMANCE OF TASK:

Operation of control must cause component to function according to manufacturer's specifications and the operation of the control must be smooth with no sticking or binding.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement control cable

ENABLING OBJECTIVES:

1. Use tool kit
2. Read and interpret manufacturer's procedure

RESOURCES:

1. **Oldsmobile Service Manual**, 1980, pp. 1A2-6, 1A3-3, (1B2-1 and 1B2-2).

TEACHING ACTIVITIES:

1. Explain the purpose of the control system assembly.
2. List the purpose of the control cable.
3. Illustrate the bowden cable.
4. Explain what the bowden cable controls.
5. Discuss how the bowden cable controls the temperature.

PERFORMANCE OBJECTIVE 85

CRITERION-REFERENCED MEASURE:

Questions

1. The ____________ ____________ controls the temperature of the A/C heating system.
2. The control cable is moved by the ____________ ____________ ____________ _________.
3. The cable should be routed so that the control lever moves ____________.

Answers

1. Bowden cable
2. A/C heater control assembly
3. Freely.

Practical Application:

Have students R & R conditioning and heater control cables.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 85 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 85 EVALUATION

PERFORMANCE TEST FOR R & R AIR CONDITIONING AND HEATER CONTROL CABLES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
PERFORMANCE GUIDE:		
1. Located and gained access to both ends of control cable.	____	____
2. Loosened and removed clamps or brackets attaching cable to control and component.	____	____
3. Loosened and disconnected cable end from control and component.	____	____
4. Removed cable and installed replacement in original position.	____	____
5. Pulled new cable into place by attaching end to old cable if this will facilitate installation in severely obstructed area.	____	____
6. Reattached ends of new cable to original control and component.	____	____
7. Installed and tightened cable mounting clamps and brackets.	____	____
8. Adjusted cable so it operates control according to manufacturer's specifications.	____	____
9. Replaced all parts previously removed to gain access to cables.	____	____

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 86

TASK: R & R ducts and outlets.

STANDARD OF PERFORMANCE OF TASK:

New duct or outlet must securely attach in original position and must allow full movement of air without obstruction.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement ducts and outlets

ENABLING OBJECTIVES:

1. Use tool kit
2. Read and interpret manufacturer's procedures

RESOURCES:

1. **Oldsmobile Service Manual,** 1980, pp. 1B5-1 to 1B5-10.

TEACHING ACTIVITIES:

1. Explain the purpose of the A/C ducts and outlets.
2. List the parts of the A/C ducts and outlets.
3. Describe the vacuum control valves used to direct the hot and cold air into the ducts and outlets.
4. Discuss the heater/A/C control assembly.
5. Sketch the vacuum routing to each vacuum valve.

PERFORMANCE OBJECTIVE 86

CRITERION-REFERENCED MEASURE:

Questions

1. The __________ __________ directs the air to the defroster duct.
2. The ________ ________ ________ allow air inside the automobile to be recirculated.
3. The heat core is located in the __________ and __________ __________.

Answers

1. Defroster valve
2. Air vacuum control
3. Selector and duct assembly.

Practical Application:

Have students R & R ducts and outlets.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 86 to determine if the assignment was complete with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 86 EVALUATION

PERFORMANCE TEST FOR R & R DUCTS AND OUTLETS

Student's Name **Date**

DIRECTIONS TO STUDENTS: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to ducts and outlets.	______	______
2.	Loosened and removed parts interfering with removal of ducts or outlet.	______	______
3.	Loosened and removed clamps, braces or straps securing duct or outlet.	______	______
5.	Removed duct or outlet from vehicle.	______	______
6.	Checked passageway connected to new duct or outlet for any obstructions and corrected as necessary.	______	______
7.	Installed new duct or outlet in original position.	______	______
8.	Reinstalled and tightened mounting screws.	______	______
9.	Reinstalled clamps, braces and straps supporting duct or outlet.	______	______
10.	Replaced parts removed to gain access to duct or outlet.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 87

TASK: Test vacuum pumps.

STANDARD OF PERFORMANCE OF TASK:

Any malfunctions or failures of the vacuum pump must be detected and noted.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Vacuum gauge

ENABLING OBJECTIVES:

1. Use vacuum gauge
2. Read and interpret manufacturer's procedures

RESOURCES:

1. **Oldsmobile Service Manual**, 1981, p. 6A5-51 - 6A5-77.

TEACHING ACTIVITIES:

1. Explain why a vacuum pump is needed on certain automobiles.
2. Discuss what a vacuum pump operates on an automobile.
3. Explain how a vacuum pump operates.
4. Explain the parts of a vacuum pump.
5. Demonstrate the disassembly of a vacuum pump.

PERFORMANCE OBJECTIVE 87

CRITERION-REFERENCED MEASURE:

Questions

1. The vacuum pump is driven by the ____________.
2. Never mount a vacuum pump in a vise because it may damage the ____________ ____________.
3. The driven gear must turn freely in ____________ ____________.

Answers

1. Camshaft
2. Drive housing
3. Both directions

Practical Application:

Have students test vacuum pumps.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 87 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 87 EVALUATION

PERFORMANCE TEST FOR TESTING VACUUM PUMPS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Attached vacuum gauge to vacuum pump outlet.		
2.	Operated pump and noted reading on gauge; compared with manufacturer's specifications.		
3.	Checked pump for fluid or abnormal air leakage.		
4.	Noted test results on work order.		

Approved: Yes ___ No ___

Evaluator's Signature Date

DUTY: MAINTAINING AND REPAIRING AIR CONDITIONING AND HEATING CONTROL UNITS

PERFORMANCE OBJECTIVE 88

TASK: R & R vacuum pumps.

STANDARD OF PERFORMANCE OF TASK:

New pump must be mounted securely and must supply rated output. Worn or cracked drive belt must be replaced and all hose connections must be clean and tight. Pump must operate without unusual vibrations or noises.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Vacuum gauge
New vacuum pump
Belt tension gauge

ENABLING OBJECTIVES:

1. Use vacuum pump
2. Read and interpret manufacturer's procedures

RESOURCES:

1. **Oldsmobile Service Manual**, 1981, P-6A-5-51 - 6A-5-77.

TEACHING ACTIVITIES:

1. Explain the reason for not operating engine without vacuum installed.
2. Describe where the vacuum pump is located on engine.
3. Discuss the parts of a vacuum pump.
4. Explain the vacuum hose routing from the vacuum pump.
5. Demonstrate the removal and reassembly of the vacuum pump in the engine.

PERFORMANCE OBJECTIVE 88

CRITERION-REFERENCED MEASURE:

Questions

1. The engine oil pump is operated by the ____________ ____________.
2. The camshaft drive the ____________ at the bottom of the pump.
3. The vacuum pump has ____________ mounting bolt.

Answers

1. Vacuum pump
2. Gear
3. One

Practical Application:

Have students R & R vacuum pumps.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 88 to determine if the assignment was completed with 100% accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 88 EVALUATION

PERFORMANCE TEST FOR R & R VACUUM PUMPS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100% is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to vacuum pump.	______	______
2.	Loosened and removed hoses and drive belts from vacuum pump.	______	______
3.	Loosened and removed pump braces or brackets.	______	______
4.	Loosened and removed pump mounting screws and pump.	______	______
5.	Installed new pump in original position.	______	______
6.	Reinstalled and tightened mounting screws.	______	______
7.	Reinstalled braces or brackets.	______	______
8.	Reinstalled drive belt if used and adjusted belt to manufacturer's specifications.	______	______
9.	Attached vacuum gauge to vacuum pump.	______	______
10.	Operated pump to verify manufacturer's specified output.	______	______
11.	Removed vacuum gauge and reinstalled hoses removed from pump.	______	______
12.	Replaced all parts previously removed to gain access to vacuum pump.	______	______

Approved: Yes ___ No ___

Evaluator's Signature **Date**

DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 89

TASK: Measure voltages in electrical circuits.

STANDARD OF PERFORMANCE OF TASK:

Voltage outside of manufacturer's specifications for the circuit must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Voltmeter.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service.**

TEACHING ACTIVITIES:

1. Identify elements of a typical automotive electrical circuit.
2. Explain what causes a flow of electricity.
3. Use basic electrical symbols to draw a simple electrical circuit.
4. Identify a series, parallel, and series -- parallel circuit.
5. Demonstrate a basic electric circuit with a battery, switch, and light.

PERFORMANCE OBJECTIVE 89

CRITERION-REFERENCED MEASURE:

Questions:

1. Any material that allows electricity to flow easily is called a __________.
2. A __________ is used to cut electricity off or on.
3. All automobiles use __________ __________.

Answers:

1. Conductor
2. Switch
3. Direct current

Practical Application:

Have students measure voltages in electrical circuits.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 89 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 89 EVALUATION

PERFORMANCE TEST FOR MEASURING VOLTAGES IN ELECTRICAL CIRCUITS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Located and gained access to electrical circuit being checked.		
2.	Activated circuit in order to obtain voltage readings.		
3.	Attached voltmeter negative lead to a good ground source.		
4.	Set meter scale so maximum possible voltage in circuit is within range of meter.		
5.	Probed wiring or connectors in circuit(s) to obtain meter reading.		
6.	Compared obtained reading with manufacturer's specified expected reading.		
7.	Disconnected voltmeter from circuits.		
8.	Noted test results on work order.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 90

TASK: Test for shorts and grounds.

STANDARD OF PERFORMANCE OF TASK:

All test equipment must be attached securely and in the correct sequence and all failures of circuits(s) must be located and noted.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
"Short finder."

ENABLING OBJECTIVES:

1. Use multimeter
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 276-277, 280-281.

TEACHING ACTIVITIES:

1. Explain a short circuit
2. Explain a grounded circuit
3. Describe the safety devices use on automobiles used to protect the different circuits.
4. Explain to the student how to identify a blown fuse.
5. Illustrate the use of a multimeter.

PERFORMANCE OBJECTIVE 90

CRITERION-REFERENCED MEASURE:

Questions:

1. A common electrical path back to the source of electricity is known as a __________.
2. A conductor accidentally touching another conductor providing a short path for electricity to flow is called a __________.
3. A safety device used to protect circuits in an automobile is called a __________.

Answers:

1. Ground
2. Short
3. Fuse

Practical Application:

Have students test for shorts and grounds.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 90 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 90 EVALUATION

PERFORMANCE TEST FOR TESTING FOR SHORTS AND GROUNDS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to circuit being tested.		
2.	Removed blown fuse and disconnected load, i.e. component being operated by circuit.		
3.	Connected test light across fuse terminals.		
4.	Moved wiring harness from side to side while watching test light.		
5.	Inspected wiring and harness if test light either goes out or comes on while harness is being moved.		
6.	Observed test light and if it comes on without load on the circuit a short circuit is indicated.		
7.	Isolated sections of circuit at wiring connectors to determine or pinpoint location/general area of shorts.		
8.	Repeated procedure along different sections until shorts are located.		
9.	Used a "short finder" (which locates shorts by detecting magnetic field created by a short) to locate hidden shorts in wiring.		
10.	Tested for inoperative ground circuit by activating electrical circuit.		
11.	Attached test light lead to battery voltage source.		
12.	Probed body ground to verify test light comes on when grounded.		
13.	Probed ground terminal or connection and observed light.		
14.	Determined cause of open ground circuit if test light does not come on.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
15. Tested for intermittent shorts by operating malfunctioning circuit and wiggle wiring, connectors and component being controlled by circuit (if it's movable) to recreate short circuit.	________	________
16. Noted test results on work order.	________	________

APPROVED: Yes _____ No ______

Evaluator's Signature   Date

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 91

TASK: Inspect fusible links, circuit breakers and fuses.

STANDARD OF PERFORMANCE OF TASK:

Defects such as broken, overheated, or burned parts must be noted and breaks or opens in fuse strips must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. Stockel, et al. **Auto Mechanics Fundamentals,** pp. 507-508.

TEACHING ACTIVITIES:

1. Discuss the different types of electrical circuits.
2. List on chalkboard the different types of protective devices used by manufacturers.
3. Describe how the protective devices operate.
4. Demonstrate on chalkboard how these devices operate.
5. Use a multimeter to test the different protective devices.

PERFORMANCE OBJECTIVE 91

CRITERION-REFERENCED MEASURE:

Questions:

1. A circuit in which a wire is broken or disconnected is called an __________.
2. The circuit protector that uses a bimetallic strip to protect a circuit is a __________.
3. A wire that uses hypalon insulation that will burn off is a __________.

Answers:

1. Open circuit
2. Circuit breaker
3. Fusible link

Practical Application:

Have student inspect fusible links, circuit breakers, and fuses.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 91 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 91 EVALUATION

PERFORMANCE TEST FOR INSPECTING FUSIBLE LINKS, CIRCUIT BREAKERS AND FUSES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Located links, circuit breakers or fuses being inspected.		
2. Checked for loose or corroded terminals.		
3. Checked for obvious overheating of fusible links or broken wiring.		
4. Inspected circuit breakers for burned terminals.		
5. Inspected fuses by noting if metallic strips in fuse was intact.		
6. Noted any defects on work order.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 92

TASK: Inspect battery electrolyte.

STANDARD OF PERFORMANCE OF TASK:

Any deviations from manufacturer's specified electrolyte level must be noted as well as any contamination of electrolyte.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Battery.

ENABLING OBJECTIVES:

1. Use battery hydrometer.
2. Follow manufacturer's specification.

RESOURCES:

1. Changelon. **Engine Performance Diagnosis and Tune-up,** pp. 27-28.

TEACHING ACTIVITIES:

1. Describe electrolyte in a fully charged battery.
2. Explain how "specific gravity" is used to determine a battery's condition.
3. Demonstrate how to use a battery hydrometer to determine the condition of the electrolyte.
4. Have students demonstrate the use of battery hydrometer.
5. Explain how temperature has an effect on specific gravity.

PERFORMANCE OBJECTIVE 92

CRITERION-REFERENCED MEASURE:

Questions:

1. A fully charged battery has electrolyte containing __________ percent sulfuric acid and __________ percent water.
2. The specific gravity of a full charged battery should be __________ to __________ at 80° F.
3. A __________ __________ is used to check the "specific gravity" in a battery.

Answers:

1. 35, 65
2. 1,260, 1,280
3. Battery Hydrometer

Practical Application:

Have students inspect battery electrolyte.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 92 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 92 EVALUATION

PERFORMANCE TEST FOR INSPECTING BATTERY ELECTROLYTE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Removed battery caps or looked through side of battery, if designed with semi-transparent case.	______	______
2. Checked for contamination or cloudiness from internal battery component break down.	______	______
3. Checked for correct amount of electrolyte by determining if level meets "full rings or marks" on battery, or is half inch above battery plates, or meets manufacturer's specifications.	______	______
4. Note any cells which have abnormally low electrolyte levels.	______	______
5. Fill to specified level with distilled water.	______	______
6. Replaced battery caps if removed.	______	______

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 93

TASK: Test specific gravity of battery electrolyte.

STANDARD OF PERFORMANCE OF TASK:

Any battery cell with a specific gravity outside of the manufacturer's specifications must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Battery
Battery hydrometer.

ENABLING OBJECTIVES:

1. Use a battery hydrometer.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. Webster. **Auto Mechanics,** pp. 248-251.
2. Stockel, et al. **Auto Mechanics Fundamentals,** pp. 472-475.

TEACHING ACTIVITIES:

1. Explain the purpose of a battery.
2. Identify the parts of a battery.
3. Describe how a battery is constructed.
4. Explain how electrolyte and lead produces electricity.
5. Discuss the safety precautions used while testing a battery.

PERFORMANCE OBJECTIVE 93

CRITERION-REFERENCED MEASURE:

Questions:

1. A battery is a __________ of electricity.
2. Electrolyte is a mixture of __________ and __________.
3. When servicing a battery, always wear __________.

Answers:

1. Source
2. Sulphuric Acid -- Distilled Water
3. Eye protector

Practical Application:

Have student test specific gravity of battery electrolyte.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 93 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 93 EVALUATION

PERFORMANCE TEST FOR TESTING SPECIFIC GRAVITY OF BATTERY ELECTROLYTE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Removed vent caps from battery.	____	____
2. Checked the temperature of the electrolyte (unless the hydrometer has a correction scale for temperature).	____	____
3. Squeezed the hydrometer bulb and drew electrolyte into the hydrometer until the float rises and floats freely.	____	____
4. Read the scale of the hydrometer to obtain the specific gravity of the electrolyte.	____	____
5. Recorded the specific gravity.	____	____
6. Repeated steps 3-5 for each cell.	____	____
7. Adjusted the recorded specific gravities for temperature of the electrolyte. (Add or subtract 0.004 for every 10 degrees the temperature is above or below 80° F, respectively).	____	____
8. Entered adjusted specific gravities on work order.	____	____

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 94

TASK: Load test the battery.

STANDARD OF PERFORMANCE OF TASK:

Load test readings must identify a battery with inability to deliver its rated load.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Battery load tester
Voltmeter
Thermometer
Battery.

ENABLING OBJECTIVES:

1. Use VAT-40.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al. **Auto Mechanics: Theory and Service,** pp. 232-234.

TEACHING ACTIVITIES:

1. Explain the different battery tests.
2. Discuss the different battery test equipment used in an automotive shop.
3. Demonstrate how to use the different types of battery test equipment.
4. Identify the different types of batteries.
5. Explain the different battery rating.

PERFORMANCE OBJECTIVE 94

CRITERION-REFERENCED MEASURE:

Questions:

1. The __________ has a voltmeter, an ammeter, and a variable electrical resistance load.
2. If a battery under a load test drops below __________ volts at 70°F, it is defective.
3. A battery that is designed not to need any additional water during their lifetime is called __________ __________ __________.

Answers:

1. Vat-40
2. 9.6
3. Maintenance free batteries

Practical Application:

Have students load test the battery.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 94 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 94 EVALUATION

PERFORMANCE TEST FOR LOAD TESTING THE BATTERY

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Connected voltmeter and battery load tester across battery terminals.		
2. Checked state of charge of battery and corrected if necessary by charging.		
3. Applied 300 amp load for 15 seconds to remove surface charge.		
4. Removed load.		
5. Waited to let battery recover.		
6. Applied load specified in battery manufacturer's specifications.		
7. Read voltage after 15 seconds and then removed load.		
8. Estimated or measured battery temperature and compared with manufacturer's load test temperature specifications.		
9. Noted test results on work order.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 95

TASK: Test starter current draw.

STANDARD OF PERFORMANCE OF TASK:

Cranking current (amperes) exceeding manufacturer's specifications must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Voltmeter
Ammeter (may be part of larger tester)
Manufacturer's specifications for current draw and cranking voltage.

ENABLING OBJECTIVES:

1. Use VAT-40.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. Webster. **Auto Mechanics,** pp. 264-274.

TEACHING ACTIVITIES:

1. Explain the operation of the starter motor.
2. Describe the construction of the starter motor.
3. Demonstrate the different starter motor circuits.
4. Describe the different starter drives.
5. Explain the solenoid action.

PERFORMANCE OBJECTIVE 95

CRITERION-REFERENCED MEASURE:

Questions:

1. The starter brushes make sliding contact with the ___________.
2. The ___________ hold the field coil in the starter housing.
3. The two windings in the solenoid are the ___________ and ___________ windings.

Answers:

1. Commutator
2. Pole shoe
3. Pulls-in, Hold-in

Practical Application:

Have student test starter current draw.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 95 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 95 EVALUATION

PERFORMANCE TEST FOR TESTING STARTER CURRENT DRAW

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Disconnected distributor primary lead or otherwise prevent engine from starting.		
2.	Placed shift lever in park or neutral with emergency brake on.		
3.	Connected ammeter into the circuit between battery and starter according to meter instructions.		
4.	Clipped negative lead of voltmeter to engine ground.		
5.	Clipped positive lead of voltmeter to starter motor terminal (may be on solenoid).		
6.	Cranked engine and read voltage and amperage.		
7.	Compared readings with manufacturer's specifications.		
8.	Reconnected wiring to enable engine to start.		
9.	Disconnected meters.		
10.	Noted test results on work order.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 96

TASK: Test starter circuit voltage drop.

STANDARD OF PERFORMANCE OF TASK:

Voltage drops in the starter circuit is greater than specified by the manufacturer and must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Voltmeter

ENABLING OBJECTIVES:

1. Use Vat-40.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al. **Auto Mechanics: Theory and Service,** pp. 307-309.

TEACHING ACTIVITIES:

1. Explain how an electric motor operates.
2. Describe the electromagnetic fields in a starter.
3. Illustrate how the armature is designed.
4. Illustrate how the field windings and pole shoes are designed.
5. Explain the starting motor circuits.

PERFORMANCE OBJECTIVE 96

CRITERION-REFERENCED MEASURE:

Questions:

1. The starting motor operates on the principle of __________.
2. The copper segments on the armature that the brushes make sliding contact with is called the __________.
3. The field coils of a starter are wrapped around the __________ __________ to create a magnetic field.

Answers:

1. Electromagnetism
2. Commutator
3. Pole shoes

Practical Application:

Have students test starter circuit voltage drop.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 96 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 96 EVALUATION

PERFORMANCE TEST FOR TESTING STARTER CIRCUIT VOLTAGE DROPS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Grounded negative voltmeter terminal.	______	______
2. Probed positive battery terminal and noted reading.	______	______
3. Noted reading again with starter engaged.	______	______
4. Probed battery terminal at starter with negative lead still grounded.	______	______
5. Noted reading and compared with one previously made.	______	______
6. Probed ignition feed wire coming from solenoid at its destination point.	______	______
7. Noted reading while cranking engine.	______	______
8. Compared readings with manufacturer's specifications.	______	______
9. Noted test results on work order.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 97

TASK: Check components and wires in starter control circuit.

STANDARD OF PERFORMANCE OF TASK:

Any defective components (i.e. ignition switch, park/neutral switch, relay or solenoid) or wires must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Voltmeter
Engine starter circuit.

ENABLING OBJECTIVES:

1. Read and interpret manufacturer's specifications.

RESOURCES:

1. Changelon. **Engine Performance diagnosis and Tune-up,** pp. 26-32.

TEACHING ACTIVITIES:

1. Define the following:
    a. Conductor
    b. Insulator
    c. Circuit
    d. Ground
    e. Open.
2. List the parts that make up the starter circuit.
3. Locate the parts of the starter system using an automobile.
4. Discuss the need of the safety switch.
5. Demonstrate how to diagnose a starting problem.
6. Have student demonstrate how to diagnose a starter problem.

PERFORMANCE OBJECTIVE 97

CRITERION-REFERENCED MEASURE:

Questions:

1. Materials that allow easy current flow is called a ____________.
2. The ____________ ____________ ____________ prevents the engine from being cranked when the transmission is in gear.
3. The ignition switch has ___________ positions.

Answers:

1. Conductor
2. Starter safety switch
3. 5

Practical Application:

Have students check components and wires in starter control circuit.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 97 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 97 EVALUATION

PERFORMANCE TEST FOR CHECKING COMPONENTS AND WIRES IN STARTER CONTROL CIRCUIT

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Disconnected distributor primary lead or otherwise prevented engine from starting according to manufacturer's procedure.		
2. Shifted transmission to neutral or park.		
3. Clipped negative lead of voltmeter to engine ground.		
4. Touched positive lead of voltmeter to positive battery post to assure there is battery voltage.		
5. Touched positive terminal probe to "start" side of ignition switch with key in "start" position. (If no voltage, switch is bad).		
6. Holding key in crank position, touched positive terminal probe to solenoid side of park/neutral switch. If voltage is present, replace park/neutral switch. If no voltage, wiring from ignition switch to neutral switch is bad.		
7. Touched positive voltmeter probe to solenoid or battery terminal of relay. (If no voltage, wire from battery to solenoid or relay is bad).		
8. Cranked engine and touched probe to solenoid or starter motor terminal of relay. (If no voltage, problem is in the solenoid or relay).		
9. Cranked engine and touched probe to starter terminal (only applicable to vehicles with starter relay). (If no voltage, problem is the wire between the relay and the starter).		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
10. Disconnected voltmeter.	______	______
11. Noted any defects on work order.	______	______

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 98

TASK: Identify problems that cause dash charge indicator to show no charge.

STANDARD OF PERFORMANCE OF TASK:

Any of the following defects must be detected: broken or shorted wires; loose connections; loose or broken drive belts; malfunctions of dash indicator bulb; malfunctions of alternator or regulator.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Ohmmeter
Voltmeter.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al. **Auto Mechanics: Theory and Service,** pp. 334-335.

TEACHING ACTIVITIES:

1. List undercharging or overcharging problems on chalkboard.
2. Discuss the effects of a loose alternator drive belt.
3. Explain alternator internal problems.
4. Discuss voltage regulator problems.
5. Illustrate how to use a multimeter to determine what part is at fault.

PERFORMANCE OBJECTIVE 98

CRITERION-REFERENCED MEASURE:

Questions:

1. The ____________ ____________ are not adjustable.
2. A broken brush can cause the alternator to ____________.
3. The ____________ ____________ can cause the dash charge indictor light to burn.

Answers:

1. Transistorized regulators
2. Undercharge
3. Diode trio

Practical Application:

Have students identify problems that cause dash charge indicator to show no charge.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 98 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 98 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING PROBLEMS THAT CAUSE DASH CHARGE INDICATOR TO SHOW NO CHARGE

____

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Refer to charging system manufacturer's service manual for correct procedure.		
2. Inspected alternator for loose or broken wires/connections, and loose or broken drive belts.		
3. Checked for any blown fuses in the charging circuit.		
4. Connected voltmeter and ammeter into charging system to determine if dash indicator is malfunctioning.		
5. By passed voltage regulator to determine whether cause is in regulator or alternator.		
6. Noted any defects on work order.		

APPROVED: Yes _____ No ______

____

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 99

TASK: Test alternator output.

STANDARD OF PERFORMANCE OF TASK:

Deviation of alternator output from manufacturer's specifications range must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Battery/starter and charging tester
Tachometer
Alternator specifications.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. Changelon. **Engine Performance Diagnosis and Tune-up,** pp. 26-32.

TEACHING ACTIVITIES:

1. List the parts of a modern charging system.
2. Explain the function of a charging system and parts.
3. Describe the purpose of a regulator.
4. Identify the alternators used on late model domestic cars.
5. Demonstrate the disassembly procedure.
6. Have a student demonstrate the disassembly procedure.

PERFORMANCE OBJECTIVE 99

CRITERION-REFERENCED MEASURE:

Questions:

1. Alternator regulators must limit ____________ output.
2. An alternator must change ____________ current into ____________ current.
3. The charging system converts mechanical energy to ____________ energy through ____________.

Answers:

1. Voltage
2. AC -- DC
3. Electrical, induction

Practical Application:

Have student test alternator output.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 99 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 99 EVALUATION

PERFORMANCE TEST FOR TESTING ALTERNATOR OUTPUT

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Determined manufacturer's specifications for output of the alternator at a given speed.	________	________
2. Connected the battery/starter and charging tester to the charging system and set its controls in accordance with its instructions.	________	________
3. Connected tachometer to the engine.	________	________
4. Started engine and ran it at the specified speed.	________	________
5. Increased the load on the alternator from the battery/starter and charging tester and noted the highest output obtained. (Caution: voltage must remain between 12 and 16 volts).	________	________
6. Turned the load off and stopped engine.	________	________
7. Compared the obtained readings with the manufacturer's specifications.	________	________
8. Noted test results on work order.	________	________

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 100

TASK: Test voltage regulator.

STANDARD OF PERFORMANCE OF TASK:

Any deviation from the manufacturer's specified voltage range must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Battery/starter and charging tester
Tachometer
Regulator Specifications
Thermometer.

ENABLING OBJECTIVES:

1. Use charging system tester.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al. **Auto Mechanics: Theory and Service,** pp. 332-334.

TEACHING ACTIVITIES:

1. Explain why a voltage regulator is necessary in the charging system.
2. Describe the different types of voltage regulators.
3. Discuss the voltage limiter relay.
4. Discuss the field relay.
5. Explain how to adjust a voltage regulator to meet manufacturer's specifications.

PERFORMANCE OBJECTIVE 100

CRITERION-REFERENCED MEASURE:

Questions:

1. The ____________ ____________ controls alternator output.
2. The ____________ ____________ operates with the ignition key on.
3. A ____________ is a specialized form of switch.

Answers:

1. Voltage regulator
2. Field relay
3. Relay

Practical Application:

Have students test voltage regulator.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 100 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 100 EVALUATION

PERFORMANCE TEST FOR TESTING VOLTAGE REGULATOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Determined the manufacturer's specifications for the correct voltage range, corrected for ambient temperature.		
2. Connected the battery/starter and charging system tester according to its instruction for a regulator test.		
3. Connected tachometer to engine.		
4. Started the engine and set to specified RPM.		
5. Set the controls of the tester according to its instructions.		
6. Noted the reading of the voltmeter on the tester.		
7. Measured the air temperature close to the regulator and noted it.		
8. Compared the voltage reading with the specifications at the measured temperature.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 101

TASK: Identify cause of lamp failure.

STANDARD OF PERFORMANCE OF TASK:

Any malfunctions of bulbs, lamp feed circuits, lamp ground circuits, and corroded or shorted terminals, wiring or connections must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Test light.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's service manual.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** p. 335.

TEACHING ACTIVITIES:

1. Identify faulty lamp.
2. Demonstrate how to gain access to the defective lamp.
3. Show how to use the multimeter to detect a voltage in the circuit.
4. Use multimeter test, the circuit controller or switch.
5. Identify the problem for the students.

PERFORMANCE OBJECTIVE 101

CRITERION-REFERENCED MEASURE:

Questions:

1. If there is no current in the circuit, the ___________ could be bad.
2. The ___________ controls the current in the light circuit.
3. The ___________ is used to test the switch.

Answers:

1. Fuse
2. Switch
3. Multimeter

Practical Application:

Have students identify cause of lamp failure.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 101 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 101 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING CAUSE OF LAMP FAILURE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to inoperative lamp being diagnosed.	________	________
2. Removed bulb and installed known good bulb in socket for quick check before proceeding with diagnosis, if feasible and/or diagnosis procedure is lengthy.	________	________
3. Activated lamp circuit being tested.	________	________
4. Grounded test light lead and probed voltage wires going to lamp and activated various bulb filaments.	________	________
5. Attached test light to battery voltage and probed ground surface or terminal on bulb.	________	________
6. If test light comes on in both tests, removed bulb and inspected socket and bulb for loose or corroded contacts.	________	________

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 102

TASK: Identify turn signal and hazard light malfunction.

STANDARD OF PERFORMANCE OF TASK:

Any malfunctioning/inoperative bulbs or sockets, loose or broken connections or shorted/bare wiring, turn signal or hazard switch and flashers must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Test light.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. **Oldsmobile Service Manual,** 1980, pp. 8A-46 -- 8A-47.

TEACHING ACTIVITIES:

1. List the parts that make up the turn signal and hazard light system.
2. Explain the operating procedure of the turn signals.
3. Explain the operation of the hazard light.
4. Identify by locating each part on an automobile.
5. List the malfunctions of each system and then the cure for each problem.

PERFORMANCE OBJECTIVE 102

CRITERION-REFERENCED MEASURE:

Questions:

1. The turn signal switch is located in the __________ __________.
2. A defective __________ will cause a hazard light malfunction.
3. The voltage to the turn hazard switch assembly is applied by the __________.

Answers:

1. Steering column
2. Flasher
3. Fuse

Practical Application:

Have student identify turn signal and hazard light malfunction.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 102 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 102 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING TURN SIGNAL AND HAZARD LIGHT MALFUNCTION

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Activated turn signal or hazard light circuit.		
2.	Inspected individual lamps in circuit for malfunctions and corrected as necessary using lamp failure diagnosis.		
3.	Replaced flasher if flashing speed differs from manufacturer's specifications.		
4.	Located and gained access to turn signal or hazard light circuit being tested.		
5.	Grounded test light and probed feed wire to flasher while circuit is activated.		
6.	Determined defect if test light does not come on.		
7.	Probed flasher output wire and checked for continuity.		
8.	Replaced flasher if lamps in circuit light do not flash.		
9.	Probed turn signal or hazard switch feed wire for voltage.		
10.	Inspected feed wire, if necessary, if voltage is not present.		
11.	Probed lamp feed wires from hazard or turn signal switch to determine if switch is operating correctly.		
12.	Referred to manufacturer's wiring diagnosis to test correct wires.		
13.	Continued if necessary along lamp(s) circuits checking connectors/connections to isolate problem.		
14.	Noted any malfunctions on work order.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 103

TASK: Identify cause of incorrect fuel and temperature gauge readings.

STANDARD OF PERFORMANCE OF TASK:

Any malfunctions of dash gauge, sending units, and wiring or connections must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit.
Fuel gauge tester.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. Toboldt, et al., **Automotive Encyclopedia,** pp. 291-292.

TEACHING ACTIVITIES:

1. Explain the ignition switch circuit.
2. Demonstrate how to use a multimeter to test ignition switch operation.
3. Have student demonstrate how to use a multimeter to test ignition switch operation.
4. Explain how to test fuel and temperature gauge correct operation.
5. Illustrate how to replace a gauge in the dash of an automobile.
6. Explain how the sending unit operates.

PERFORMANCE OBJECTIVE 103

CRITERION-REFERENCED MEASURE:

Questions:

1. The two types of fuel gauges are __________ __________ and __________ __________ __________.
2. The gauge pointer is controlled by a __________ __________.
3. The G.M. tank unit uses a __________ to adjust the resistance of the amount of fuel in a tank.

Answers:

1. Thermostatic type and balancing coil type.
2. Bimetallic arm.
3. Rheostat

Practical Application:

Have students identify cause of incorrect fuel and temperature gauge readings.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 103 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 103 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING CAUSES OF INCORRECT FUEL AND TEMPERATURE GAUGE READINDS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Turned ignition on to activate gauge.	______	______
2. Checked fuse and gauge voltage regulator if several gauges are inoperative at once.	______	______
3. Checked for broken, loose, or corroded wires/connections.	______	______
4. Disconnected lead at sending unit and watched for gauge movement.	______	______
5. Grounded wire from sending unit and noted gauge movement.	______	______
6. Replaced gauge if previous tests cause gauge to move.	______	______
7. Used fuel gauge tester, if available, to test fuel gauge or sending unit. Operated tester according to manufacturer's instructions.	______	______
8. Referred to manufacturer's gauge diagnosis procedures if gauge test results are inconclusive.	______	______
9. Noted any defects on work order.	______	______

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 104

TASK: Identify the cause of horn malfunctions.

STANDARD OF PERFORMANCE OF TASK:

Any defect of horn, horn relay or horn switch must be detected; any broken, loose or corroded connections of the horn wiring must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit.
Test Light.
Horn.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 391-392.

TEACHING ACTIVITIES:

1. List the parts of the horn circuit.
2. Explain the parts of the horn circuit.
3. Discuss the horn relay.
4. Locate the location of the horn circuit parts.
5. Illustrate how to diagnose horn malfunction.

PERFORMANCE OBJECTIVE 104

CRITERION-REFERENCED MEASURE:

Questions:

1. The horn switch is mounted in the ___________ ___________.
2. The horn switch activates ___________ to transfer voltage to the horns.
3. The horns are located behind the ___________ of an automobile.

Answers:

1. Steering wheel
2. Relay
3. Grill

Practical Application:

Have students identify the cause of horn malfunctions.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 104 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 104 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING THE CAUSE OF HORN MALFUNCTIONS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Inspected wiring and components for obviously broken parts or loose connections.		
2. Grounded test light lead and probed horn feed wire while activating horn circuit: if test light comes on, horn is defective.		
3. Gained access to wire from horn switch and checked operation with test light while operating switch.		
4. Probed horn switch wire at horn relay to determine if malfunction is in wiring between the relay and the switch.		
5. Probed horn relay power feed to check for voltage to determine if relay is receiving current.		
6. Probed horn relay output wire to determine if the relay is malfunctioning or if problem is between relay and horn.		
7 Noted any defects on work order.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: DIAGNOSING THE AUTOMOBILE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 105

TASK: Identify the cause of windshield wiper/washer malfunctions.

STANDARD OF PERFORMANCE OF TASK:

Any defects in the following parts must be detected: wiper motor or circuit breaker; loose or broken wires; pinched or leaking hoses; wiper or washer switches; washer pump, hoses or reservoir; wiper linkages.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Ammeter.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. Matt, Stephen A., **Electricity and Basic Electronics,** pp. 170-176.

TEACHING ACTIVITIES:

1. Explain how an electromagnet operates.
2. Discuss the electromagnet used in electric motors.
3. Describe how the armature is designed and built.
4. Illustrate, using the chalkboard, how the field windings are constructed.
5. Explain the commutator and brush set-up used in electric motors.

PERFORMANCE OBJECTIVE 105

CRITERION-REFERENCED MEASURE:

Questions:

1. Brushes used in electric motors are usually made of ___________.
2. The commutator is made of ___________.
3. The windings in the field produce a ___________.

Answers:

1. Carbon
2. Copper
3. Magnet

Practical Application:

Have students identify the cause of windshield wiper/washer malfunctions.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 105 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 105 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING THE CAUSE OF WINDSHIELD WIPER/ WASHER MALFUNCTIONS

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Operates windshield wiper/washer unit to determine which function is incorrectly operating or malfunctioning.		
2. Checked washer system by first verifying there is fluid in washer reservoir and there are no restrictions or leaks in the hoses, nozzles and pump.		
3. Operates pump to determine whether malfunction is mechanical or electrical.		
4. Operates pump circuit to check for complete voltage and ground circuits.		
5. Operates windshield wiper circuit to determine if wipers are malfunctioning or inoperative.		
6. Checked for loose or binding wiper linkages.		
7. Tested for inoperative wiper motor by applying voltage directly to wiper motor feed wire(s).		
8. Checked wiper parts, relays, switches if motor operates in bypass test.		
9. Checked for proper ground of wiper motor to chassis.		
10. Tested wiper dash switch and wiring if malfunction is determined to be in that area.		
11. Tested parts, switches and relays inside wiper motor by referring to specific manufacturer's service manuals.		
12. Attached ammeter in series with wiper motor feed wire and while in operation compare with manufacturer's specifications.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 106

TASK: R and R alternator brushes.

STANDARD OF PERFORMANCE OF TASK:

The rotor spins freely and the rated output of the alternator must meet manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement Brushes
Brush Retaining Pin
Crocus cloth.

ENABLING OBJECTIVES:

1. Read and interpret manufacturer's procedures.
2. Use standard tool set.

RESOURCES:

1. Changelon. **Engine Performance Diagnosis and Tune-up.**

TEACHING ACTIVITIES:

1. Discuss the purpose of the charging system.
2. List the parts of the charging system.
3. Define the term induction.
4. Describe the construction of alternator brushes.
5. Explain why brushes are used in an alternator.

PERFORMANCE OBJECTIVE 106

CRITERION-REFERENCED MEASURE:

Questions:

1. Alternator current must be __________ to direct current for automotive use.
2. The alternator brushes make sliding contact with the __________ __________.
3. The alternator __________ creates a magnet field.

Answers:

1. Rectified
2. Slip Rings
3. Rotor

Practical Application:

Have students R and R alternator brushes.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 106 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 106 EVALUATION

PERFORMANCE TEST FOR R AND R ALTERNATOR BRUSHES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Disconnected electrical connections to brushes.	____	____
2. Removed brushes and brush holder, or both along with attaching screws or clips.	____	____
3. Inspected insulated washers or sleeves.	____	____
4. Installed new brushes in brush holder and retained with brush holding pin, if necessary until reassembly of alternator.	____	____
5. Installed brush holder in alternator.	____	____
6. Cleaned commutator on rotor with crocus cloth.	____	____
7. Reattached electrical connections and tightened to manufacturer's specifications for torque.	____	____
8. Reassembled alternator.	____	____
9. Pulled brush retaining pin.	____	____
10. Checked alternator output.	____	____

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 107

TASK: Test alternator diodes and/or rectifier bridge.

STANDARD OF PERFORMANCE OF TASK:

Diodes and rectifiers with readings outside manufacturer's specifications must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Ohmmeter
Alternator.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. Changelon. **Engine Performance Diagnosis and Tune-up.**

TEACHING ACTIVITIES:

1. Explain why diodes are used in alternators.
2. Discuss the construction of diodes.
3. Describe how diodes are installed in the alternators.
4. Explain the use of heat sinks.
5. Demonstrate how to test diodes.

PERFORMANCE OBJECTIVE 107

CRITERION-REFERENCED MEASURE:

Questions:

1. The ___________ prevents the battery from discharging through the alternators.
2. Most alternators have ___________ positive and ___________ negative diodes.
3. The ___________ ___________ helps to remove heat from the positive diode.

Answers:

1. Diode
2. Three (3), Three (3)
3. Heat Sink

Practical Application:

Have students test alternator diodes and/or rectifier bridge.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 107 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 107 EVALUATION

PERFORMANCE TEST FOR TESTING ALTERNATOR DIODES AND/OR RECTIFIER BRIDGES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Removed diodes and/or rectifier bridge from alternator.	______	______
2. Set ohmmeter to manufacturer's recommended scale.	______	______
3. Attached ohmmeter leads to the connectors of a diode and note reading.	______	______
4. Reversed ohmmeter connections and note second reading.	______	______
5. Compared readings. (Readings should be different if diode is good).	______	______
6. Repeated test on each diode.	______	______
7. Repeated test on each of the three connectors of the rectifier bridge.	______	______
8. Noted test results on work order.	______	______

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 108

TASK: R and R alternator diodes.

STANDARD OF PERFORMANCE OF TASK:

Diodes or assemblies must be installed observing proper polarity; all connections must be clean and tight; all fasteners must be torqued to manufacturer's specifications. Alternator shaft must rotate freely and when tested alternator must meet manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Alternator Brushes Holder Pin
Yellow Grease Pencil
Diode Assemblies
Soldering Gun
Solder
Alternator.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. Matt, Stephen A., **Electricity and Basic Electronics,** pp. 214-219.

TEACHING ACTIVITIES:

1. Explain the purpose of a diode.
2. Demonstrate, on chalkboard, how a diode operates.
3. Discuss how the alternator produces A/C current.
4. Explain the difference between A/C and D/C current.
5. Identify the diodes in an alternator.

PERFORMANCE OBJECTIVE 108

CRITERION-REFERENCED MEASURE:

Questions:

1. The ___________ allows current flow in only one direction.
2. A diode is a ___________ ___________.
3. Diodes change ___________ current into ___________.

Answers:

1. Diode
2. Semi-Conductor
3. A/C, D/C

Practical Application:

Have students R and R alternator diode.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 108 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 108 EVALUATION

PERFORMANCE TEST FOR R AND R ALTERNATOR DIODES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Removed alternator from car.		
2.	Secured alternator in vise.		
3.	Removed alternator drive pulley attaching nut and washer.		
4.	Marked alternator case halves to aid in identifying for reassembly.		
5.	Removed alternator case-to-case attaching bolts.		
6.	Separated alternator housings being careful to avoid losing the brush springs.		
7.	Removed diode assembly.		
8.	Replaced assembly as a unit; if replacing individual diodes refer to alternator manufacturer's recommendations for replacement procedures.		
9.	Installed diode assembly retainer bolts and torque to manufacturer's specifications.		
10.	Reinstalled parts previously removed for diode access.		
11.	Tightened connections to manufacturer's specifications.		
12.	Retracted brushes and secured with brush holder pin.		
13.	Rejoined case halves; realigned case index marks.		
14.	Reinstalled case halves attaching bolts and torque to manufacturer's specifications.		
15.	Pulled brush holder.		
16.	Reattached drive pulley, spacers, etc.		

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
17.	Reinstalled drive pulley nut and washer and torque to manufacturer's specifications.	______	______
18.	Tested alternator output.	______	______

APPROVED: Yes ______ No ______

Evaluator's Signature Date

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 109

TASK: Test alternator rotor.

STANDARD OF PERFORMANCE OF TASK:

Any short or open circuits or current draw outside of manufacturer's specifications must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Ohmmeter
Ammeter
Test Lead
Automotive Battery
Alternator.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. Webster. **Auto Mechanics,** pp. 282-293.

TEACHING ACTIVITIES:

1. Explain the design of the rotor.
2. Discuss magnetism of the rotor.
3. Describe how the rotor induces high voltage.
4. Explain the stator windings.
5. Illustrate how the rotor and stator produces high voltage.

PERFORMANCE OBJECTIVE 109

CRITERION-REFERENCED MEASURE:

Questions:

1. The magnetic field in an alternator is created in the __________.
2. High voltage is induced in the __________.
3. An alternator produce __________ current without the use of diodes.

Answers:

1. Rotor
2. Stator
3. Alternating

Practical Application:

Have students test alternator rotor.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 109 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 109 EVALUATION

PERFORMANCE TEST FOR TESTING ALTERNATOR ROTOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Inspected rotor for wear or scoring on shaft or slip rings.	______	______
2. Set ohmmeter to manufacturer's recommended scale.	______	______
3. Connected one ohmmeter lead to each slip ring and note reading. (Ohmmeter should read low).	______	______
4. Removed lead from one slip ring and attached to stator shaft and noted reading. (Ohmmeter should read high).	______	______
5. Attached one test lead from a negative battery terminal to slip ring; attached ammeter test leads to other battery terminal and other slip ring, and noted reading. (Reading should not exceed the manufacturer's specifications for field circuit current draw).	______	______
6. Noted test results on work order.	______	______

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 110

TASK: R and R alternator rotor.

STANDARD OF PERFORMANCE OF TASK:

Rotor and drive must rotate freely and all fasteners must be torqued to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Bearing Grease
Yellow Grease Pencil
Alternator Brushes Holder Pin
Alternator Rotor.

ENABLING OBJECTIVES:

1. Use hand tools.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 282-288.

TEACHING ACTIVITIES:

1. Explain the construction of the alternator rotor.
2. Explain how the rotor produces a magnetic field build-up.
3. Illustrate how the magnetic field and stator produces electricity.
4. Demonstrate how to test a rotor for grounds or open circuits.
5. Have students test rotors for grounds or open circuits.

PERFORMANCE OBJECTIVE 110

CRITERION-REFERENCED MEASURE:

Questions:

1. The alternator brushes are made of ___________.
2. The rotor windings and slip rings are ___________ from the rotor shaft.
3. The rotor produce a ___________ ___________ to generate current in the stator.

Answers:

1. Carbon
2. Insulated
3. Magnetic Field

Practical Application:

Have students R and R an alternator rotor.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 110 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 110 EVALUATION

PERFORMANCE TEST FOR R AND R ALTERNATOR ROTOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Removed alternator from car.		
2.	Secured alternator in vise.		
3.	Removed alternator drive pulley attaching nut and washer.		
4.	Removed drive pulley, spacers/cooling fan.		
5.	Referred to manufacturer's recommendations if pulley is pressed on shaft.		
6.	Marked alternator case halves to aid in identifying for eventual reassembly.		
7.	Removed alternator case-to-case attaching bolts.		
8.	Separated alternator housings being careful to avoid losing the brush springs.		
9.	Removed rotor from case half while tapping on shaft and holding housing.		
10.	Inspected bearings and cleaned, repacked or replaced if necessary.		
11.	Installed new rotor in case half.		
12.	Retracted brushes and secured with brush holder.		
13.	Rejoined case halves realigning index marks.		
14.	Reinstalled case halves attaching bolts and torque to manufacturer's specifications.		
15.	Pulled brush holder.		
16.	Reattached drive pulley, spacers, etc.		
17.	Reinstalled drive pulley nut and washer and torque to manufacturer's specifications.		
18.	Tested alternator output.		

APPROVED: Yes _______ No ________

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 111

TASK: Test alternator stator.

STANDARD OF PERFORMANCE OF TASK:

Leads must be attached and readings outside of stator manufacturer's test specifications must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Ohmmeter.

ENABLING OBJECTIVES:

1. Use multimeter.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service.**

TEACHING ACTIVITIES:

1. Explain the stator functions.
2. Illustrate the stator windings on chalkboard.
3. Discuss how the stator is designed.
4. Explain why the stator windings are connected to the diodes.
5. Demonstrate how to diagnose stator troubles.

PERFORMANCE OBJECTIVE 111

CRITERION-REFERENCED MEASURE:

Questions:

1. The alternator stator contains ___________ windings.
2. The ends of the stator windings are connected to ___________.
3. A ____________ is used to test stator windings for shorts or open circuits.

Answers:

1. Three
2. Diodes
3. Multimeter

Practical Application:

Have students test alternator stator.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 111 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 111 EVALUATION

PERFORMANCE TEST FOR TESTING ALTERNATOR STATOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Inspected stator for broken, burned or shorted wires/insulation.		
2. Checked stator for open connections by attaching ohmmeter leads to any two stator leads.		
3. Repeated test with any remaining leads on stator.		
4. Attached one ohmmeter lead to stator frame.		
5. Attached remaining lead in succession to each stator lead.		
6. Referred to manufacturer's specifications for correct resistance readings.		
7. Discarded stator if alternator still fails output tests and other components are operating properly.		
8. Noted results on work order.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 112

TASK: R and R alternator stator.

STANDARD OF PERFORMANCE OF TASK:

Alternator drive must spin freely with no internal interference or noise and all bolts must be secured and torqued to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Stator
Soldering gun
Solder
Yellow grease pencil
Alternator
Brush holding pin
Alternator.

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 328-333.

TEACHING ACTIVITIES:

1. Explain how the stator is constructed.
2. Discuss how the alternator produces electricity.
3. Explain the rectifier assembly.
4. Show where the brushes are located in an alternator.
5. Explain the purpose of the diode trio.

PERFORMANCE OBJECTIVE 112

CRITERION-REFERENCED MEASURE:

Questions:

1. The alternator stator contains __________ windings.
2. The __________ __________ changes AC current to DC current.
3. The __________ in an alternator make sliding contact with the slip rings.

Answers:

1. Three
2. Rectifier assembly
3. Brushes

Practical Application:

Have students R and R an alternator stator.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 112 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 112 EVALUATION

PERFORMANCE TEST FOR R AND R AN ALTERNATOR STATOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Removed alternator from car.		
2.	Secured alternator in vise.		
3.	Removed alternator drive pulley attaching nut and washer.		
4.	Marked alternator case halves to aid in identifying for eventual reassembly.		
5.	Removed alternator case-to-case attaching bolts.		
6.	Separated alternator housings being careful to avoid losing the brush springs.		
7.	Removed alternator parts obstructing access to stator and connections.		
8.	Disconnected stator leads by removing bolts/nuts holding leads or unsolder if required.		
9.	Removed stator by gently prying between stator frame and case with a small screwdriver.		
10.	Installed new stator in case.		
11.	Reattached stator leads and alternator by soldering or tightening with original hardware.		
12.	Reinstalled parts removed for stator access and tightened connections.		
13.	Retracted brushes and secured with brush holder.		
14.	Rejoined case halves realigning index marks.		
15.	Reinstalled case halves attaching bolts and torqued to manufacturer's specifications.		
16.	Pulled brush holder.		
17.	Reinstalled drive pulley nut and washer and torqued to manufacturer's specifications.		
18.	Tested alternator for noise and output.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 113

TASK: Adjust voltage regulator output.

STANDARD OF PERFORMANCE OF TASK:

Regulator adjustment procedure must conform to manufacturer's recommended procedures and charging output must meet manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Ammeter
Voltmeter.

ENABLING OBJECTIVES:

1. Use VAT-40.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 332-335.

TEACHING ACTIVITIES:

1. Discuss the purpose of the voltage regulator.
2. Explain the different types of voltage regulators.
3. Demonstrate how the voltage regulator operates.
4. Discuss the field relay circuit in a voltage regulator.
5. Demonstrate how to diagnose voltage regulator troubles.

PERFORMANCE OBJECTIVE 113

CRITERION-REFERENCED MEASURE:

Questions:

1. Voltage regulator must limit ___________ ___________ of an alternator.
2. Solid state voltage regulators control voltage by use of ___________.
3. The ___________ ___________ are used to apply bias current to the regulator transistors.

Answers:

1. Voltage output
2. Transistors
3. Diode trios

Practical Application:

Have students adjust voltage regulator output.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 113 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 113 EVALUATION

PERFORMANCE TEST FOR ADJUSTING VOLTAGE REGULATOR OUTPUT

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Disconnected positive battery cable.		
2. Disconnected alternator output lead.		
3. Attached ammeter between alternator output wire and alternator output stud observing the correct polarity.		
4. Reconnected battery cable.		
5. Attached voltmeter across battery terminals.		
6. Started vehicle and adjusted voltage regulator output according to vehicle manufacturer's procedures and specifications.		
7. Stopped engine after adjusting regulator.		
8. Removed voltmeter and disconnected positive battery cable.		
9. Removed ammeter and reattached alternator output wire to alternator.		
10. Reattached battery cable.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 114

TASK: R and R alternator bearing.

STANDARD OF PERFORMANCE OF TASK:

Alternator shaft must spin freely with no looseness or noise; all bolts must be secure and torqued to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Small bearing puller
Bearings
Bearing grease
Small hydraulic press
Yellow grease pencil
Alternator brush holder pin.

ENABLING OBJECTIVES:

1. Use bearing puller.
2. Follow manufacturer's procedure.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 328-332.

TEACHING ACTIVITIES:

1. Discuss how the alternator operates.
2. Explain the parts of an alternator.
3. Illustrate how the diode changes AC current to DC current.
4. Demonstrate the disassembly and reassembly of an alternator.
5. Have student demonstrate the disassembly and reassembly of an alternator.

PERFORMANCE OBJECTIVE 114

CRITERION-REFERENCED MEASURE:

Questions:

1. The AC current is produced in the ___________.
2. The magnetic field is produced by the ___________.
3. The alternator rotor is supported by the use of two ___________.

Answers:

1. Stator
2. Rotor
3. Bearings

Practical Application:

Have students R and R an Alternator bearing.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 114 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 114 EVALUATION

PERFORMANCE TEST FOR R AND R ALTERNATOR BEARING

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Removed alternator from car.		
2. Secured alternator in vise.		
3. Removed alternator drive pulley attaching nut and washer.		
4. Removed drive pulley, spacers/cooling fan.		
5. Referred to manufacturer's recommendations if pulley is pressed on shaft.		
6. Marked alternator case halves to aid in identifying for eventual reassembly.		
7. Removed alternator case-to-case attaching bolts.		
8. Separated alternator housings being careful to avoid losing the brush springs.		
9. Removed alternator parts obstructing access to bearings.		
10. Removed bearings according to manufacturer's recommendations.		
11. Removed any accumulated dirt and grease from bearing areas.		
12. Lubricated and installed new bearings according to manufacturer's recommendations.		
13. Reinstalled parts removed for bearing access and tightened connections to manufacturer's specifications.		
14. Retracted brushes and secured with brush holder.		
15. Rejoined case halves realigning index marks.		
16. Reinstalled case halves attaching bolts and torqued to manufacturer's specifications.		
17. Pulled brush holder.		
18. Reattached drive pulley, spacers, etc.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
19. Reinstalled drive pulley nut and washer and torqued to manufacturer's specifications.	______	______
20. Reinstalled alternator in vehicle.	______	______
21. Reconnected battery cables.	______	______
22. Tested alternator and verified manufacturer's specified output.	______	______

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 115

TASK: Clean battery, posts and cable connections.

STANDARD OF PERFORMANCE OF TASK:

Terminals must be clean and tight with all corrosion removed and battery and terminal dry.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Putty knife
Battery terminal and post brush
Air blow gun
Baking soda and water mixture
Battery terminal sealer
Rubber gloves
Protective goggles
Battery.

ENABLING OBJECTIVES:

1. Use battery terminal cleaner.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 290-296.

TEACHING ACTIVITIES:

1. Explain the construction of a battery.
2. Discuss the function and operation of a battery.
3. Describe problems that can shorten battery life.
4. Explain the different ratings for battery capacities.
5. Demonstrate how to service a battery.

PERFORMANCE OBJECTIVE 115

CRITERION-REFERENCED MEASURE:

Questions:

1. The mixture of pure water and sulphuric acid is called ___________.
2. The battery is a ___________ of electricity.
3. Each cell of a fully charged battery has a voltage of ___________ volts.

Answers:

1. Electrolyte
2. Source
3. 2.1

Practical Application:

Have student clean battery, posts, and cable connections.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 115 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 115 EVALUATION

PERFORMANCE TEST FOR CLEANING BATTERY, POSTS AND CABLE CONNECTIONS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Loosened and removed clamps/connectors.		
2. Applied cleaning solution to battery, posts and cable connection if excessive build up requires it. (Caution: battery acid is corrosive).		
3. Rinsed solution from battery and connectors with water and blew dry if cleaning solution was used. (Caution: Wear eye protection when working with compressed air).		
4. Checked surrounding areas for spattered acid or cleaning solution and removed.		
5. Scraped/brushed battery, posts, terminals, connectors, tray and hold-down.		
6. Reattached cables to battery.		
7. Torqued bolts to manufacturer's specifications.		
8. Sealed posts/terminals with battery terminal sealer.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 116

TASK: R and R battery.

STANDARD OF PERFORMANCE OF TASK:

New battery must be secured on battery tray and battery and connections sealed and tight.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Battery carrier
Battery (and acid, if necessary)
Protective goggles and rubber gloves
Battery charger
Battery load tester
Protective goggles.

ENABLING OBJECTIVES:

1. Use VAT-40.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 298-302.

TEACHING ACTIVITIES:

1. Discuss the safety procedure while working with batteries.
2. Explain how to test a battery using a battery hydrometer.
3. Demonstrate how to use a battery hydrometer.
4. Demonstrate how to load test a battery using the VAT-40.
5. Have student demonstrate how to perform both hydrometer and load test.

PERFORMANCE OBJECTIVE 116

CRITERION-REFERENCED MEASURE:

Questions:

1. The battery hydrometer is used to test the ____________ ____________ of a battery.
2. The ____________ is used to load test a battery.
3. The first step in performing any battery test is to secure a pair of ____________.

Answers:

1. Specific gravity
2. VAT-40
3. Safety glasses

Practical Application:

Have students R and R a battery.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 116 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 116 EVALUATION

PERFORMANCE TEST FOR R AND R BATTERY

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Loosened and removed clamps/connectors from old battery.		
2. Loosened and removed battery hold-down straps.		
3. Removed or repositioned obstructions/ brackets.		
4. Attached battery carrier tools to old battery according to carrier instructions. (Caution: Battery acid is corosive; avoid spillage).		
5. Lifted battery from vehicle and detached carrier.		
6. Installed acid in new battery if required per manufacturer's instructions.		
7. Pre-charged new battery if necessary by attaching battery charger to new battery following charger's instructions.		
8. Removed any spilled acid and dry battery.		
9. Attached battery carrier to battery and placed battery in tray.		
10. Cleaned any corrosion from clamps, connectors, tray, hold-downs, and straps.		
11. Repositioned previously removed obstructions.		
12. Reattached battery hold-downs/straps and tightened belts.		
13. Reattached battery clamps and torqued to manufacturer's specifications.		
14. Sealed battery terminals.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 117

TASK: R and R battery cables.

STANDARD OF PERFORMANCE OF TASK:

Cables must be secured and routed to manufacturer's requirements; all connections must be clean and tight.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement cables
Battery terminal cleaner
Battery terminal sealer
Protective goggles.

ENABLING OBJECTIVES:

1. Use tool kit.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. deKryger, et al., **Auto Mechanics: Theory and Service,** pp. 298-305.

TEACHING ACTIVITIES:

1. Describe how wiring connections are made in a vehicle.
2. Identify parts of vehicle wiring diagrams.
3. Discuss wires and their locations on vehicles.
4. Locate battery cables on a vehicle.
5. Demonstrate the proper procedure for removing and replacing battery cables.

PERFORMANCE OBJECTIVE 117

CRITERION-REFERENCED MEASURE:

Questions:

1. Always replace the ____________ battery cable first.
2. The battery positive cable is attached to the ____________ ____________.
3. To ensure a good connection between the battery post and cable, all connections must be ____________ and ____________.

Answers:

1. Positive
2. Starter solenoid
3. Clean, tight

Practical Application:

R and R battery cables.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 117 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 117 EVALUATION

PERFORMANCE TEST FOR R AND R BATTERY CABLES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED		Satisfactory	Unsatisfactory
1.	Loosened and disconnected cables from battery.		
2.	Removed clamps and/or straps starting with ground cable.		
3.	Disconnected cable at its termination point and discarded.		
4.	Installed new cable routing through original cable's clamps/straps.		
5.	Reattached termination point(s).		
6.	Tightened termination connections to manufacturer's specifications.		
7.	Positioned or adjusted cable to avoid abrasion or excess heat from exhaust system.		
8.	Removed positive battery cable clamps/ connectors.		
9.	Disconnected at termination point and discarded.		
10.	Routed new cable through original cable's clamps/straps.		
11.	Reattached at termination point(s).		
12.	Tightened termination connectors to manufacturer's specifications.		
13.	Positioned or adjusted cable to avoid abrasion of excess heat from exhaust system.		
14.	Cleaned and dried battery posts, terminals, hold-downs if necessary.		
15.	Reattached battery cables to battery.		
16.	Tightened to manufacturer's specifications.		
17.	Sealed terminals.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 118

TASK: Charge battery.

STANDARD OF PERFORMANCE OF TASK:

Charger cables must be properly connected and charge rate set according to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Battery charger
Battery tester
Battery.

ENABLING OBJECTIVES:

1. Use a VAT-40.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. Toboldt, et al. **Automotive Encyclopedia,** pp. 446-457.

TEACHING ACTIVITIES:

1. Explain the principle of battery operation.
2. List the parts that make up a battery element.
3. Describe the composition of electrolyte.
4. Define the term specific gravity.
5. Explain how specific gravity is used to determine a battery's condition.

PERFORMANCE OBJECTIVE 118

CRITERION-REFERENCED MEASURE:

Questions:

1. A fully charged battery will have a specific gravity of __________ to __________.
2. A battery cell will produce about __________ volts.
3. The specific gravity in a battery is checked with a __________ __________.

Answers:

1. 1.260 to 1.280
2. 2.1
3. Battery hydrometer

Practical Application:

Have students charge a battery.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 118 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 118 EVALUATION

PERFORMANCE TEST FOR CHARGING A BATTERY

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Attached battery tester to battery to determine state of charge, open and/or shorted cells.		
2.	Checked cells and added water if level is below manufacturer's recommended level. (Caution: Battery acid is corrosive; avoid spillage).		
3.	Connected charging cables to battery posts observing correct polarity.		
4.	Connected battery charger to appropriate grounded electrical outlet and turned on.		
5.	Charged battery at manufacturer's recommended rate.		
6.	Reduced charging rate if battery is boiling or spitting liquid.		
7.	Shut off charge and disconnected charging cables from battery.		
8.	Retested battery to verify battery meets capacity requirements; continued charging if necessary.		
9.	Rechecked water level in cells and added water if necessary to reach indicated fill heights.		
10.	Removed any spilled acid or water from battery and surrounding area.		
11.	Secured battery clamps/strips/terminals as necessary according to manufacturer's specifications.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 119

TASK: R and R alternator.

STANDARD OF PERFORMANCE OF TASK:

Alternator must be mechanically secure, all electrical connections secure, and alternator drive belt must meet manufacturer's recommended tension.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Battery charging system tester
New alternator
Alternator drive belt
Belt tension gauge.

ENABLING OBJECTIVES:

1. Use tool kit.
2. Read and interpret manufacturer's service manual.

RESOURCES:

1. Toboldt, et al., **Automotive Encyclopedia,** pp. 354-357.

TEACHING ACTIVITIES:

1. Define the term "induction" as it is used in the charging system.
2. Identify the two voltage sources that are in the alternator.
3. Explain how a magnetic field is established.
4. Explain how a voltage is produced in the stator.
5. Illustrate how the diode rectifies the A/C current into D/C current.

PERFORMANCE OBJECTIVE 119

CRITERION-REFERENCED MEASURE:

Questions:

1. The charging system converts some engine ____________ energy to ____________ energy.
2. Alternators use ____________ to rectify A/C current into D/C current.
3. The ____________ produces the magnetic field in the alternator.

Answers:

1. Mechanical, electrical
2. Diodes
3. Rotor

Practical Application:

Have students R and R an alternator.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 119 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 119 EVALUATION

PERFORMANCE TEST FOR R AND R AN ALTERNATOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Loosened and disconnected battery ground cables.		
2. Loosened and disconnected electrical connections at alternator.		
3. Loosened alternator attaching bolts and disconnected drive belt.		
4. Removed or repositioned brackets, hoses, etc. as necessary.		
5. Removed alternator attaching bolts.		
6. Removed alternator from vehicle.		
7. Inspected new alternator for loose bolts or connectors.		
8. Transferred any parts from old to new alternator if required for installation.		
9. Temporarily secured alternator in position with one or more bolts.		
10. Reattached brackets and/or braces between alternator and engine.		
11. Tightened brackets and braces leaving adjusting bolts finger tight until final adjustment.		
12. Inspected drive belt for cracks or excessive wear -- replaced if necessary.		
13. Attached drive belt to alternator.		
14. Set drive belt tension to manufacturer's specifications.		
15. Maintained proper tension while torquing adjusting bolts to manufacturer's specifications.		
16. Reattached electrical connections to alternator.		
17. Positioned wiring if necessary to avoid interference with moving engine parts.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
18. Rechecked attaching bolts for correct torque.	________	________
19. Reconnected battery cables to respective terminals and torqued to manufacturer's specifications.	________	________
20. Attached charging system tester per manufacturer's instructions and verified alternator output per manufacturer's specifications.	________	________

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 120

TASK: R and R starter drive.

STANDARD OF PERFORMANCE OF TASK:

Starter drive must be positioned correctly on armature shaft and move freely without binding; solenoid plunger fork must be engaged correctly on drive collar; armature shaft must be able to be rotated without binding.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
New starter
Starter drive
Oil
Vise
Battery charger.

ENABLING OBJECTIVES:

1. Use tool kit.
2. Read and interpret manufacturer's procedures.

RESOURCES:

1. deKryger, et al. **Auto Mechanics: Theory and Service,** pp. 310-312.

TEACHING ACTIVITIES:

1. Explain the function of a start drive.
2. List the different types of start drives.
3. Demonstrate the inertia drive starter drive.
4. Demonstrate the overrunning clutch starter drive.
5. Illustrate how to remove and replace a starter drive.

PERFORMANCE OBJECTIVE 120

CRITERION-REFERENCED MEASURE:

Questions:

1. The ratio between the starter drive and flywheel is __________.
2. The __________ __________ transmits the rotating force of the starter to crank the engine.
3. The inertia drive is located on the starter __________.

Answers:

1. 15:1
2. Overrunning clutch
3. Armature

Practical Application:

R and R starter drive.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 120 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 120 EVALUATION

PERFORMANCE TEST FOR R AND R STARTER DRIVE

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Supported starter securely.		
2. Removed starter drive retainer following manufacturer's procedures.		
3. Removed starter drive.		
4. Cleaned and lubricated starter drive mounting surface and/or shaft.		
5. Installed replacement starter drive making sure it slides freely back and forth in grooves.		
6. Installed thrust collars and starter drive retainer.		
7. Bench tested to verify operation.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 121

TASK: R and R starter relay and/or solenoid.

STANDARD OF PERFORMANCE OF TASK:

Solenoid/relay must move starter drive to fully engaged position without sticking or binding.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Starter solenoid.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize and use starter solenoid or relay.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 66-69.

TEACHING ACTIVITIES:

1. Explain the types of starter control switches.
2. Show the operation of a starter solenoid.
3. Draw the wiring connections of the solenoid.
4. Explain the safety measures that must be taken when clamping the field frame assembly in a vise.
5. Demonstrate the proper method of removing a solenoid off a starter.

PERFORMANCE OBJECTIVE 121

CRITERION-REFERENCED MEASURE:

Questions:

1. What are the two electric devices that cause the starting motor to connect with the engine flywheel?
2. The ___________ mounted on the starting motor closes the electrical circuit and meshes the pinion with the flywheel.
3. In the starting motor with the ___________ ___________ the field winding moves the starter drive into the flywheel.

Answers:

1. Solenoid, sliding pole shoe
2. Solenoid
3. Sliding pole shoe

Practical Application:

Remove and replace starter relay and/or solenoid.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 121 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 121 EVALUATION

PERFORMANCE TEST FOR R AND R STARTER RELAY AND/OR SOLENOID

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
	(Solenoid in Starter Unit)		
1.	Supported starter by securely clamping field frame in vise. (Caution: Avoid distorting field frame by overtightening vise).		
2.	Disconnected starter field coil strap at solenoid.		
3.	Loosened and removed bolts attaching solenoid to starter drive and housing.		
4.	Rotated solenoid 90 degrees and removed.		
5.	Installed solenoid onto starter and tightened bolts securely.		
6.	Reconnected field coil terminal strap to solenoid.		
	(Solenoid Outside of Starter Unit)		
1.	Disconnected wires from solenoid; marked correct positions.		
2.	Loosened and removed bolts holding solenoid to firewall or inside fender.		
3.	Removed solenoid.		
4.	Installed new solenoid in place and bolted securely in place.		
5.	Reconnected solenoid wires.		
6.	Checked for correct solenoid operations.		

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 122

TASK: R and R voltage regulator.

STANDARD OF PERFORMANCE OF TASK:

Voltage regulator must be fastened securely in place with wires connected according to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Grease pencil.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize external regulator and alternators which have internal regulators.
3. Identify alternators with built-in regulator.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 128-137.

TEACHING ACTIVITIES:

1. Review safety procedures for dealing with electrical systems.
2. Discuss the purpose of a voltage regulator.
3. Dismantle an alternator and show where the regulator is located.
4. Have student read and discuss textbook **Electronics and Electrical Equipment,** pp. 128-137.
5. Discuss the location of regulators on the automobile.

PERFORMANCE OBJECTIVE 122

CRITERION-REFERENCED MEASURE:

Questions:

1. What is the purpose of the voltage regulator?
2. The ___________ should be disconnected before you break a connection on any electrical circuit.
3. Internal regulators are located inside the ___________.

Answers:

1. To control alternator output.
2. Battery
3. Alternator

Practical Application:

Remove and replace voltage regulator.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 122 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 122 EVALUATION

PERFORMANCE TEST FOR R AND R VOLTAGE REGULATOR

Student's Name Date

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Loosened and disconnected battery ground cable.		
2. Located and gained access to voltage regulator as necessary.		
EXTERNAL REGULATOR		
1. Loosened and disconnected wiring/connectors at regulator.		
2. Loosened and removed bolts securing regulator to vehicle.		
3. Removed regulator.		
4. Installed new regulator and attached with existing or new bolts if necessary.		
5. Reattached electrical wiring and connectors to new regulator.		
INTERNAL REGULATOR		
1. Secured alternator in vise.		
2. Removed alternator drive pulley attaching nut and washer.		
3. Marked alternator case halves to aid in identifying for eventual reassembly.		
4. Removed alternator case-to-case attaching bolts.		
5. Separated alternator housings being careful to avoid losing the brush springs.		
6. Removed alternator parts obstructing access to regulator.		
7. Removed bolts or screws securing regulator to case.		
8. Removed regulator.		

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
9.	Installed new regulator and reinstalled original bolts/screws/connectors.	______	______
10.	Reinstalled alternator parts obstructing access to regulator.	______	______
11.	Retracted brushes and secured with brush holder.	______	______
12.	Rejoined case halves realigning index marks.	______	______
13.	Reinstalled case halves attaching bolts and torqued to manufacturer's specifications.	______	______
14.	Pulled brush holder.	______	______
15.	Reinstalled alternator in vehicle.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 123

TASK: Inspect starter drive gear.

STANDARD OF PERFORMANCE OF TASK:

Any chipped gear teeth, worn bushings or shaft, or faulty operation of the starter clutch assembly must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
New starter drive
Starter armature.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize a starter drive and starter armature.

RESOURCES:

1. Crouse. **Electrical and Electronic Equipment,** pp. 87-90.

TEACHING ACTIVITIES:

1. Discuss the operation of the starter drive.
2. Explain how to test the starter drive.
3. Describe the special tools to remove and replace starter drive.
4. Explain the different types of starter drives.
5. Demonstrate how to R and R a starter drive.

PERFORMANCE OBJECTIVE 123

CRITERION-REFERENCED MEASURE:

Questions:

1. The drive on some starting motors are held on by a collar, retainer and ____________.
2. If the starter drive is found to slip in the drive direction replace the:
   a. Assembly
   b. Rollers
   c. Drive pinion.
3. Clearance between the pinion and the ____________ should be checked when installing a starter drive.

Answers:

1. Snap ring
2. a
3. Thrust washer

Practical Application:

Inspect a starter drive gear.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 123 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 123 EVALUATION

PERFORMANCE TEST FOR INSPECTING STARTER DRIVE GEAR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Inspected starter drive for obvious defects or broken parts such as chipped or missing teeth.		
2. Slid starter drive onto armature shaft.		
3. Noted any excessive play or binding while sliding drive back and forth on shaft.		
4. Moved starter drive pinion gear from side to side.		
5. Compared the amount of movement with the manufacturer's specifications.		
6. Verified operation of clutch assembly in starter drive by attempting to rotate drive pinion in both directions and compared with new drive.		
7. Noted any defects on work order.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 124

TASK: R and R starter.

STANDARD OF PERFORMANCE OF TASK:

All electrical connections must be clean and tight and starter must be secured and torqued according to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
New starter
Medium prybar.

ENABLING OBJECTIVES:

1. Recognize engine starter and battery.
2. Use tools in standard tool kit.
3. Use floor jack and stands or hydraulic lift.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 81-86.

TEACHING ACTIVITIES:

1. Discuss safety procedures in the use of electrical components.
2. Demonstrate the proper method of R and R a starter.
3. Explain how to R and R a starter.
4. Discuss the different types of starters.
5. Define wiring connections on a starter.
6. Discuss the purpose of starter shims.

PERFORMANCE OBJECTIVE 124

CRITERION-REFERENCED MEASURE:

Questions:

1. __________ the battery before removing the starter.
2. Check for __________ between starter drive and the flywheel.
3. The starter on some automobiles use __________ between the starter and engine block.

Answers:

1. Disconnect
2. Mesh
3. Shims

Practical Application:

Remove and replace a starter.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 124 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 124 EVALUATION

PERFORMANCE TEST FOR R AND R STARTER

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Loosened and disconnected battery ground cable.	________	________
2. Gained access to underside of vehicle.	________	________
3. Loosened and removed bolts securing flywheel shield as necessary.	________	________
4. Removed flywheel shield as necessary.	________	________
5. Removed exhaust system as necessary to gain access to starter.	________	________
6. Loosened bolts and removed any starter support straps or heat shields.	________	________
7. Disconnected electrical connections to starter.	________	________
8. Loosened and removed starter attaching bolts while supporting starter.	________	________
9. Removed starter from vehicle.	________	________
10. Removed any shims if used.	________	________
11. Positioned new starter and reattached original shims if used.	________	________
12. Attached retaining bolts and torqued to manufacturer's specifications.	________	________
13. Reattached electrical connections to starter.	________	________
14. Reattached support straps or heat shields to starter being careful to avoid pinching any electrical wiring.	________	________
15. Reattached any exhaust system parts removed.	________	________
16. Reinstalled flywheel shield.	________	________
17. Reattached battery cables.	________	________
18. Checked for mesh of starter drive gear and flywheel ring gear.	________	________

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 125

TASK: R and R starter brushes.

STANDARD OF PERFORMANCE OF TASK:

Brushes must contact commutator squarely; connections must be clean and tight; springs must provide manufacturer's specified brush tension; brush leads must be positioned to avoid shorts or abrasion.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Set of brushes
Brush tension gauge
Battery charger.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Use a battery charger.
3. Recognize parts of a starter.
4. Recognize a standard vise.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 87-91.

TEACHING ACTIVITIES:

1. Explain the theory of the starting motor.
2. Discuss the parts of the starter.
3. Explain the safety measure to be taken with electrical devices.
4. Demonstrate the proper method or disassembling a starter.
5. Discuss the different kinds of brush holders.
6. Demonstrate how to bench test a starter.

PERFORMANCE OBJECTIVE 125

CRITERION-REFERENCED MEASURE:

Questions:

1. The brushes contact the ____________ on the end of the armature.
2. A ___________ ___________ is used to bench test a starter.
3. Snapping the brushes down may cause the brush to:
   a. Crack
   b. Commutator to bend
   c. Brush holder to distort.

Answers:

1. Commutator
2. Battery charger
3. a

Practical Application:

Remove and replace starter brushes.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 125 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 125 EVALUATION

PERFORMANCE TEST FOR R AND R STARTER BRUSHES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Supported starter by securely clamping field frame in vise. (Caution: Avoid distorting field frame by overtightening vise).		
2.	Disconnected starter field coil strap at solenoid.		
3.	Loosened and removed through bolts at commutator end plate.		
4.	Removed commutator end plate and thrust washer.		
5.	Loosened and removed bolts attaching solenoid to starter drive end housing.		
6.	Removed starter drive housing, armature and solenoid from field frame.		
7.	Removed pivot pins and springs from brush holders.		
8.	Positioned brushes in order to remove brush lead screws.		
9.	Loosened screws and removed brushes from starter.		
10.	Inserting new brushes in starter attaching to original leads.		
11.	Installed and tightened securely brush lead retaining screws.		
12.	Reinstalled brush springs and pins making sure they are engaged properly on brush holders.		
13.	Attached armature drive housing and solenoid to field frame aligning index pins while holding brushes against field housing.		
14.	Verified brushes are making full contact against commutator adjusting as necessary and making sure insulated brush leads are not shorting against frame.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
15. Compared brush tension to manufacturer's specifications using a brush tension gauge and adjusted if necessary. Replaced springs if necessary.		
16. Attached commutator end plate and thrust washer.		
17. Installed and tightened through bolts.		
18. Reconnected field coil terminal strap to solenoid.		
19. Bench tested starter to verify operation.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 126

TASK: R and R starter bushings.

STANDARD OF PERFORMANCE OF TASK:

Bushings must be seated squarely in end housings and shaft ends must slide into end housings without being too tight or loose.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Bushing puller
Bushings
Snap ring pliers.

ENABLING OBJECTIVES:

1. Use standard tool kit, bushing puller, snap ring pliers.
2. Recognize parts of a starter.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 94-95.

TEACHING ACTIVITIES:

1. Explain the purpose of the starter bushings.
2. Discuss different sizes of starting motor bushings.
3. Demonstrate how to use a bushing puller to remove the bushing from a starter.
4. Demonstrate how to check for bushing wear.
5. Show that some bushings can't be replaced.

PERFORMANCE OBJECTIVE 126

CRITERION-REFERENCED MEASURE:

Questions:

1. The bushing holds the starter __________ in place.
2. A bushing __________ is used to remove a bushing from a starter housing.
3. Always check clearance between the bushing and the armature __________.

Answers:

1. Armature
2. Puller
3. Shaft

Practical Application:

R and R starter bushings.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 126 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 126 EVALUATION

PERFORMANCE TEST FOR R AND R STARTER BUSHING

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Supported starter by securely clamping field frame in vise. (Caution: Avoid distorting field frame by overtightening vise).		
2.	Disconnected starter field coil strap at solenoid.		
3.	Loosened and removed through bolts at commutator end plate.		
4.	Removed commutator end plate and thrust washer.		
5.	Loosened and removed bolts attaching solenoid to starter drive end housing.		
6.	Rotated solenoid 90 degrees and removed.		
7.	Removed plunger return spring.		
8.	Slid starter drive housing and armature from field frame.		
9.	Removed shift lever, retaining pin and snap ring from drive end housing.		
10.	Removed armature from end housing.		
11.	Removed thrust collar from armature shaft.		
12.	Removed bushings from end housing with bushing puller per manufacturer's procedures.		
13.	Positioned new bushing over recess in end housing.		
14.	Selected correct bushing driver from bushing installation kit.		
15.	Installed driver onto bushing and drove squarely and fully into bushing recess.		
16.	Repeated procedure for other end housing.		
17.	Checked fit of bushings with corresponding ends of armature shaft.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
18. Removed any burrs or corrected for binding as necessary.	_____	_____
19. Attached armature and end housing to starter field frame aligning index pins while holding brushes against field housing.	_____	_____

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 127

TASK: Test starter armature.

STANDARD OF PERFORMANCE OF TASK:

Any shorts, grounds or open circuits and any dial indicator readings outside of manufacturer's specifications must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Armature growler
V-blocks
Dial indicator.

ENABLING OBJECTIVES:

1. Recognize parts of a starting motor.
2. Use tools in a standard tool kit.

RESOURCES:

1. Crouse. **Electronics and Electrical Equipment,** pp. 91-95.

TEACHING ACTIVITIES:

1. Explain what an armature does.
2. Show a visual illustration of an armature.
3. Define an armature growler.
4. Demonstrate an armature growler.
5. Explain the usage of V-blocks and a dial indicator.
6. Demonstrate how to use V-blocks and a dial indicator.

PERFORMANCE OBJECTIVE 127

CRITERION-REFERENCED MEASURE:

Questions:

1. The growler is used to test the armature for:
    a. Short circuit
    b. Open circuit
    c. Current.
2. Open circuit in the armature will produce a __________ commutator bars.
3. An armature out of round can be checked with a set of V-blocks and a __________.

Answers:

1. a
2. Burned
3. Dial indicator

Practical Application:

Test a starter armature.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 127 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 127 EVALUATION

PERFORMANCE TEST FOR TESTING A STARTER ARMATURE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Checked armature for signs of overheating.		
2. Placed armature on growler and connected growler to outlet.		
3. Tested armature for shorts and grounds according to instructions for growler.		
4. Placed armature on V-blocks supporting bearing area of shaft.		
5. Set and adjusted dial indicator placing pointer on commutator surface.		
6. Zeroed dial indicator and rotated armature while noting reading variations.		
7. Compared readings to manufacturer's specifications.		
8. Repositioned dial indicator as close to center of armature shaft as possible.		
9. Positioned pointer on shaft and zeroed indicator.		
10. Rotated armature and compared readings with manufacturer's specifications.		
11. Noted test results on work order.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 128

TASK: R and R starter armature.

STANDARD OF PERFORMANCE OF TASK:

Starter armature shaft must be able to rotate freely without binding or play outside of manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Battery charger
New armature
Oil
Vise
Starter.

ENABLING OBJECTIVES:

1. Use a battery charger.
2. Recognize the parts of a starter.
3. Use tools in a standard tool kit.

RESOURCES:

1. Crouse. **Electronics and Electrical Equipment,** pp. 90-97.
2. **Chevrolet Service Manual,** 1981, (No. ST 329-81).

TEACHING ACTIVITIES:

1. Dismantle a starter and identify the names of each part of the starter.
2. Demonstrate how to use a battery charger to bench test a starter.
3. Explain how to check an armature to meet specifications.
4. Have student read **Chevrolet Service Manual,** 1981, and be prepared to discuss procedures.
5. Demonstrate how to check clearance between the housing and armature.

PERFORMANCE OBJECTIVE 128

CRITERION-REFERENCED MEASURE:

Questions:

1. The __________ __________ has to be replaced on the end of a new armature.
2. Support a starter securely in a __________ before disassembly.
3. To bench test a starter the __________ has to be flashed jumped momentarily.

Answers:

1. Starter drive
2. Vise
3. Solenoid

Practical Application:

Remove and replace starter armature.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 128 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 128 EVALUATION

PERFORMANCE TEST FOR R AND R STARTER ARMATURE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Supported starter securely in vise.		
2.	Removed field coil strap if required.		
3.	Loosened and removed bolts holding end plate.		
4.	Removed end plate.		
5.	Removed starter drive.		
6.	Removed starter armature.		
7.	Lubricated replacement armature shaft with thin coat of oil.		
8.	Installed armature into housing making sure drive lever fingers are engaged and brushes engage commutator.		
9.	Installed end plate and tightened bolts.		
10.	Reconnected field coil strap.		
11.	Bench tested starter.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 129

TASK: Test field circuits.

STANDARD OF PERFORMANCE OF TASK:

Any shorts or open circuits must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Starter field coil
Frame assembly ohmmeter.

ENABLING OBJECTIVES:

1. Recognize and use an ohmmeter.
2. Recognize a starter field coil assembly.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 94-95.

TEACHING ACTIVITIES:

1. Explain the basic theory of electrical current flow.
2. Discuss various types of ohmmeters.
3. Demonstrate how to use an ohmmeter.
4. Explain an open and shorted circuit.
5. Demonstrate how to R and R field coils from the housing.

PERFORMANCE OBJECTIVE 129

CRITERION-REFERENCED MEASURE:

Questions:

1. Electrical current will follow the path with:
   a. Least resistance
   b. Greater resistance
   c. Grounded resistance.
2. An ohmmeter is used to check for __________ and open electrical circuit.
3. When installing the field windings, be sure to replace the __________ strip in their original positions.

Answers:

1. a
2. Shorted
3. Insulating

Practical Application:

Test a field circuit.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 129 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 129 EVALUATION

PERFORMANCE TEST FOR TESTING A FIELD CIRCUIT

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Inspected coils for burned insulation, broken or shorted or loosened connections, or obvious overheating.		
2. Set ohmmeter to I K scale.		
3. Located both leads for each field coil and attached leads of ohmmeter to coil leads.		
4. Replaced coil if reading shows resistance above or below manufacturer's specifications.		
5. Repeated procedure for remaining coils.		
6. Attached one lead of ohmmeter to field frame.		
7. Attached remaining lead to a lead of each coil.		
8. Replaced coil(s) if ohmmeter needle indicates a low resistance reading.		
9. Noted test results on work order.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 130

TASK: Test solenoid.

STANDARD OF PERFORMANCE OF TASK:

Faulty operation of the solenoid, and any shorts or open circuits must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Solenoid assembly with starter attached
Heavy duty battery tester
Jumper wire
Ohmmeter.

ENABLING OBJECTIVES:

1. Use tools in a standard tool kit.
2. Recognize and use an ohmmeter.
3. Recognize and use a battery charger.
4. Recognize a starter with a solenoid attached.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** p. 81.

TEACHING ACTIVITIES:

1. Explain how a solenoid works.
2. Draw the wiring connections of a solenoid and discuss the purpose of each wire.
3. Demonstrate how to check a solenoid using an ohmmeter.
4. Demonstrate how to check a solenoid using a battery charger.
5. Demonstrate how to R and R a solenoid from a starter.

PERFORMANCE OBJECTIVE 130

CRITERION-REFERENCED MEASURE:

Questions:

1. The ohmmeter is used to test the solenoid for a __________ circuit and a __________ circuit.
2. The solenoid is a __________ switch.
3. The solenoid shifts the starter drive in mesh with the flywheel and connects the __________ with the starting motor.

Answers:

1. Open, shorted
2. Electromagnetic
3. Battery

Practical Application:

Test a solenoid.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 130 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 130 EVALUATION

PERFORMANCE TEST FOR TESTING A SOLENOID

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Supported starter by securely clamping field frame in vise. (Caution: Avoid distorting field frame by overtightening vise).		
2. Inspected for cracks or obviously worn parts.		
3. Disconnected and moved field wire away from solenoid terminal.		
4. Attached battery charger negative lead to starter frame.		
5. Attached positive lead to battery terminal on solenoid.		
6. Connected charger to outlet and turned on charger.		
7. Connected a jumper wire to main lead on solenoid and attached other end to terminal marked SOLENOID/SOL. or switch terminal.		
8. Checked for full movement of solenoid plunger and shifted lever assembly.		
9. Checked for proper forward movement of starter drive.		
10. Removed solenoid from starter and checked for binding plunger shift lever or starter drive, if plunger did not operate correctly in previous test.		
11. Attached test light ground lead to starter frame; while leaving jumper in place and charger still connected, probed solenoid terminal marked relay, if used.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
12. Replaced solenoid if test light did not come on.	__________	__________
13. Tested solenoid for open windings by attaching ohmmeter leads to solenoid case and main solenoid battery terminal.	__________	__________
14. Replaced solenoid if ohmmeter indicates high resistance or open windings.	__________	__________

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 131

TASK: R and R field circuits.

STANDARD OF PERFORMANCE OF TASK:

Fields must be secured in place to prevent movement short circuits or abrasion from internal moving parts and field clamp bolts must be tight and staked to prevent loosening from vibrations from starter operations.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
New fields
Impact driver kit
Vise
Battery charger.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize and use impact driver.
3. Recognize and use battery charger.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 95-96.

TEACHING ACTIVITIES:

1. Demonstrate how to disassemble a starter.
2. Explain safety rules to follow when using a battery charger.
3. Discuss different ways field windings are mounted in a starting housing.
4. Explain the usage of an impact driver.
5. Define the wiring connections of the field winding.
6. Demonstrate how to R and R field winding in the housing.

PERFORMANCE OBJECTIVE 131

CRITERION-REFERENCED MEASURE:

Questions:

1. Field windings are held in place by a field ___________ screw.
2. The field windings are wrapped around a field ___________.
3. The field windings have to be placed in the same ___________ as the windings being replaced.

Answers:

1. Clamp
2. Shoe
3. Position

Practical Application:

Remove and replace a field circuit.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 131 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 131 EVALUATION

PERFORMANCE TEST FOR R AND R FIELD CIRCUITS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Supported starter by securely clamping field frame in vise. (Caution: Avoid distorting field frame by overtightening vise).		
2.	Loosened and removed through bolts at commutator end plate.		
3.	Removed commutator end plate and thrust washer.		
4.	Loosened and removed bolts attaching solenoid to starter drive end housing.		
5.	Rotated solenoid 90 degrees and removed.		
6.	Removed plunger return spring.		
7.	Slid starter drive housing and armature from field frame.		
8.	Removed armature from end housing.		
9.	Disconnected field terminals from brush assemblies.		
10.	Removed field clamp screws from field frame using impact driver.		
11.	Removed fields and field retaining plates from field frame.		
12.	Installed field support plates in new field assemblies.		
13.	Reinstalled into field frame in original field position for proper alignment of field terminals with respective brushes.		
14.	Installed field clamp bolts using impact driver and staked into position.		
15.	Reattached field terminals to brush assemblies.		
16.	Attached commutator end plate and thrust washer.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
17. Verified brushes are fully and squarely seated on commutator; adjusted if necessary.		
18. Inspected fields and wiring; positioned/ adjusted if necessary to avoid shorts or abrasion from other parts.		
19. Attached commutator end plate and thrust washer.		
20. Installed and tightened through bolts.		
21. Installed plunger return spring.		
22. Installed solenoid onto starter and tightened bolts securely.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 132

TASK: Test switches.

STANDARD OF PERFORMANCE OF TASK:

Any electrical or mechanical defects in the switches must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
12 volt source
Volt-ohmmeter.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize and use 12 volt battery.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 300-305.

TEACHING ACTIVITIES:

1. Explain Ohm's Law.
2. Show how to use a volt-ohmmeter.
3. Draw a wiring diagram using a switch.
4. Discuss safety rules to follow when working with electricity.
5. Show different switches used in the automobile.
6. Demonstrate how to check a switch with an ohmmeter.

PERFORMANCE OBJECTIVE 132

CRITERION-REFERENCED MEASURE:

Questions:

1. An ohmmeter should read ___________ when checking a switch in a closed position.
2. Three things are needed to make an electrical circuit; volts, amps, and ___________.
3. A typical head light switch has ___________ positions.

Answers:

1. Zero
2. Resistance
3. Three

Practical Application:

Test switches.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 132 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 132 EVALUATION

PERFORMANCE TEST FOR TESTING SWITCHES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Referred to manufacturer's description of switch being tested to understand design action of switch.	____	____
2. Inspected switch for broken parts or loose connections.	____	____
3. Removed wires from switch terminals.	____	____
4. Checked resistance with volt-ohmmeter across terminals in both open and closed switch position.	____	____
5. Compared readings; should be infinite in open position and zero in closed position.	____	____
6. Repeated tests if switch has multiple operating functions.	____	____
7. Noted test results on work order.	____	____

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 133

TASK: Test fuses.

STANDARD OF PERFORMANCE OF TASK:

Any defects in the end caps or terminals, or a high resistance or open circuit must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Ohmmeter and fuse.

ENABLING OBJECTIVES:

1. Use a standard ohmmeter.
2. Recognize a fuse.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 17-18.

TEACHING ACTIVITIES:

1. Explain safety measures to follow when working with electrical components.
2. Show the different types of fuses.
3. Explain how a fuse works and what causes them to go bad.
4. Demonstrate how to check a fuse with an ohmmeter.
5. Illustrate where fuses are located on an automobile.

PERFORMANCE OBJECTIVE 133

CRITERION-REFERENCED MEASURE:

Questions:

1. Most electrical circuits have a __________ or circuit breakers.
2. A bad fuse will have __________ resistance when checked with an ohmmeter.
3. The two types of fuses used are the cartridge fuse and __________ fuse.

Answers:

1. Fuse
2. High
3. U-shaped

Practical Application:

Test fuses.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 133 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 133 EVALUATION

PERFORMANCE TEST FOR TESTING FUSES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Removed fuse from fuse holders.	____	____
2. Inspected fuse for loose or damaged end caps or terminals.	____	____
3. Set ohmmeter leads to each fuse terminal.	____	____
4. Attached ohmmeter leads to each fuse terminal.	____	____
5. Discarded fuse if ohmmeter shows high resistance or open circuit.	____	____

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 134

TASK: R and R fuses.

STANDARD OF PERFORMANCE OF TASK:

Fuse must be removed and replaced without breaking or damaging fuseholder or panel; new fuse must be installed securely and must pass current.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Fuse puller
Voltmeter.

ENABLING OBJECTIVES:

1. Recognize a fuse.
2. Recognize and use a voltmeter.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 17-18.

TEACHING ACTIVITIES:

1. Explain where fuse box is located on an automobile.
2. Demonstrate how to use a fuse puller.
3. Demonstrate how to check for voltage at each end of a fuse holder.
4. Discuss different size of fuses and how to tell the size.
5. Demonstrate how to remove a fuse from an inline fuse holder.

PERFORMANCE OBJECTIVE 134

CRITERION-REFERENCED MEASURE:

Questions:

1. A ___________ is used to remove a fuse from a fuse box.
2. Check for voltage at each end of a ___________ using a voltmeter.
3. A group of fuses are located together in a _________ _________.

Answers:

1. Fuse puller
2. Fuse
3. Fuse box

Practical Application:

R and R fuses.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 134 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 134 EVALUATION

PERFORMANCE TEST FOR R AND R FUSES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Located and gained access to fuseholders or panel.	____	____
2. Twisted and separated fuseholder or attached fusepuller to fuse at panel.	____	____
3. Removed fuse.	____	____
4. Installed replacement fuse by pressing into clips of panel or inserting it into fuseholder and reconnecting.	____	____
5. Checked for correct voltage at each end of fuse with a voltmeter.	____	____

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 135

TASK: Test circuit breakers.

STANDARD OF PERFORMANCE OF TASK:

Loose or corroded terminals and any deviations from manufacturer's amperage tolerance must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Circuit breaker
12 volt power source which can deliver more than rated amperage of circuit breaker
Battery load tester.

ENABLING OBJECTIVES:

1. Recognize and use a 12 volt battery.
2. Use a battery load tester.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 17-18.

TEACHING ACTIVITIES:

1. Explain how a circuit breaker works.
2. Discuss safety rules to follow when working with electricity.
3. Demonstrate how to use a load tester to check a circuit breaker.
4. Identify different breakers used on an automobile.
5. Discuss why circuit breakers are different from fuses.

PERFORMANCE OBJECTIVE 135

CRITERION-REFERENCED MEASURE:

Questions:

1. A circuit breaker does the same job as a ___________ except they do not blow.
2. A circuit breaker is designed to control the ___________ of a circuit.
3. A battery load tester is used to test the ___________ of a breaker.

Answers:

1. Fuse
2. Amperage
3. Capacity

Practical Application:

Test circuit breakers.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 135 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 135 EVALUATION

PERFORMANCE TEST FOR TESTING CIRCUIT BREAKERS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Removed circuit breaker or disconnected wires at terminals.	______	______
2.	Attached the lead of source to one terminal of circuit breaker.	______	______
3.	Attached one lead of the battery load tester to remaining circuit breaker terminal.	______	______
4.	Attached other lead of battery load tester to power source.	______	______
5.	Increased tester load to rated capacity of circuit breaker.	______	______
6.	Increased load further by approximately 25 percent of rated capacity.	______	______
7.	Observed amperage required to trip circuit breaker.	______	______
8.	Verified that circuit breaker resets.	______	______
9.	Removed load.	______	______
10.	Disconnected power source and loaded tester leads.	______	______
11.	Reinstalled circuit breaker.	______	______
12.	Noted results on work order.	______	______

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 136

TASK: R and R fuse block assembly.

STANDARD OF PERFORMANCE OF TASK:

New fuse block must be securely positioned in place and all wiring is reconnected in original positions with clean and tight connections.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Fuse puller
Fuse block
Wire marking tags.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize fuse block.

RESOURCES:

1. Crouse. **Electronics and Electrical Equipment,** pp. 16-17.

TEACHING ACTIVITIES:

1. Explain the purpose of fuses.
2. Show a sketch of where the fuse block is located.
3. Demonstrate how to use a fuse puller.
4. Explain how to identify wire so as to replace in the correct order.
5. Explain safety measure to follow when working with electrical components.

PERFORMANCE OBJECTIVE 136

CRITERION-REFERENCED MEASURE:

Questions:

1. The ___________ cable must be disconnected before working with electrical systems.
2. Wire must be tagged to insure correct ___________.
3. Where are most fuse boxes located?

Answers:

1. Ground
2. Reinstallation
3. Under the dash

Practical Application:

R and R fuse block assembly.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 136 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 136 EVALUATION

PERFORMANCE TEST FOR R AND R FUSE BLOCK ASSEMBLY

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Disconnected battery ground.		
2. Gained access to fuse block.		
3. Loosened and removed attaching bolts.		
4. Tagged or marked wires for correct reinstallation.		
5. Disconnected wires from block.		
6. Removed fuse block from vehicle.		
7. Transferred fuses, circuit breakers, turn signals, and other components to new block.		
8. Positioned new fuse block and reconnected wiring.		
9. Attached bolts and secured in place.		
10. Reconnected battery terminals.		
11. Operated accessories to verify connections.		

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 137

TASK: Inspect lighting system for faulty bulbs.

STANDARD OF PERFORMANCE OF TASK:

Any defective bulbs must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Test light.

ENABLING OBJECTIVES:

1. Use test light.
2. Recognize lighting system bulbs.

RESOURCES:

1. Crouse. **Electronics and Electrical Equipment,** pp. 303-305.

TEACHING ACTIVITIES:

1. Explain an electrical circuit.
2. Demonstrate how to use a test light.
3. Show and discuss a wiring diagram.
4. Discuss how to check a light bulb.
5. Discuss safety rules to follow when working with electricity.

PERFORMANCE OBJECTIVE 137

CRITERION-REFERENCED MEASURE:

Questions:

1. Use a ____________ ____________ to check a circuit for current.
2. The ____________ glows and produces light in a bulb.
3. A light socket must have current and a good ____________.

Answers:

1. Test light
2. Filament
3. Ground

Practical Application:

Inspect lighting system for faulty bulbs.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 137 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 137 EVALUATION

PERFORMANCE TEST FOR INSPECTING LIGHTING SYSTEM FOR FAULTY BULBS

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Energized circuits and observed bulb operation.		
2.	Removed bulb and inspected for broken filament or socket.		
3.	Probed socket for current at bulb feed.		
4.	Attached test light to wire and probed ground (bulb should light).		
5.	Replaced bulb if test light lights in steps 3 and 4.		
6.	Noted results on work order.		

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 138

TASK: R and R light bulbs.

STANDARD OF PERFORMANCE OF TASK:

Replacement must light constantly at full intensity compared with other lights and bulb must be at rated capacity of original.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Replacement bulb
Scraper.

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Recognize light bulbs according to size.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 292-294.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when dealing with electrical system.
2. Show and discuss a chart location and types of light bulbs used on automobiles.
3. Demonstrate how to remove lens covers.
4. Demonstrate how to R and R light bulbs.
5. Show how to check a circuit.

PERFORMANCE OBJECTIVE 138

CRITERION-REFERENCED MEASURE:

Questions:

1. A ___________ must be removed to gain access to most tail light bulbs.
2. A bulb which is either ___________ or loose will not burn.
3. A new bulb must be at rated ___________ of original.

Answers:

1. Lens
2. Corroded
3. Capacity

Practical Application:

R and R light bulbs.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 138 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 138 EVALUATION

PERFORMANCE TEST FOR R AND R LIGHT BULBS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Gained access to bulb by removing brackets on lenses as necessary.		
2.	Removed bulb retaining clamps if used.		
3.	Removed plugs or connectors at bulb if used.		
4.	Removed bulb.		
5.	Inspected and removed any corrosion of dirt from socket.		
6.	Replaced or repaired any loose or corroded connections.		
7.	Plugged in new bulb or reattached electrical connections if used.		
8.	Verified bulb operation.		
9.	Reinstalled bulb retaining clips originally removed.		
10.	Reinstalled lenses or covers.		
11.	Rechecked bulb operation.		

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 139

TASK: R and R sockets.

STANDARD OF PERFORMANCE OF TASK:

Socket must be installed securely with no pinched or shorted wiring and lamp must light as specified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Terminal connector kit
Sockets.

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Use terminal connector tool.

RESOURCES:

1. **Chevrolet Manual,** 1981, pp. 813-814.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electricity.
2. Demonstrate how to splice wires.
3. Explain wiring color code identification.
4. Demonstrate how to remove socket from the housing.
5. Demonstrate how to remove bulb from socket.

PERFORMANCE OBJECTIVE 139

CRITERION-REFERENCED MEASURE:

Questions:

1. Electrical wires are ___________ coded.
2. ___________ current on a circuit before working on it.
3. Wires have to be ___________ or unplugged from the socket.

Answers:

1. Color
2. Disconnect
3. Cut

Practical Application:

R and R light sockets.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 139 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 139 EVALUATION

PERFORMANCE TEST FOR R AND R LIGHT SOCKETS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Loosened and disconnected battery ground cable or shut off circuit being worked on.		
2. Located and gained access to socket.		
3. Removed bulb if reusable.		
4. Unplugged or disconnected/cut wires to socket leaving sufficient length to attach to leads of new socket.		
5. Removed screws, clamps, brackets retaining socket in fixture.		
6. Removed socket from fixture.		
7. Installed new socket and secured with original hardware.		
8. Plugged socket into original wiring or reattached with electrical splices butt connectors using instructions in terminal kit.		
9. Reinstalled bulb.		
10. Activated electrical circuit to verify wires are connected to proper filaments in bulb.		
11. Reinstalled lenses or covers previously removed to gain access to socket.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 140

TASK: Adjust headlights.

STANDARD OF PERFORMANCE OF TASK:

Headlights must be aimed to provide maximum allowable road illumination and must also meet state/local authorities and manufacturer's headlamp aiming requirements.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Headlamp aimer.

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Recognize headlights.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** p. 298.

TEACHING ACTIVITIES:

1. Discuss the importance of correct headlamp aiming.
2. Show location of aiming screws.
3. Show different types of aiming instruments.
4. Discuss the effect of an uneven floor.
5. Demonstrate how to set headlamps.

PERFORMANCE OBJECTIVE 140

CRITERION-REFERENCED MEASURE:

Questions:

1. When aiming headlamps the car must be parked on ___________ surface.
2. Tires must be to ___________ pressure.
3. Headlamp adjustment is made by turning the ___________ screws.

Answers:

1. Level
2. Specified
3. Spring loaded

Practical Application:

Adjust headlights.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 140 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 140 EVALUATION

PERFORMANCE TEST FOR ADJUSTING HEADLIGHTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Parked vehicle on level surface.	______	______
2. Checked vehicle for broken or sagging springs.	______	______
3. Bounced each end of vehicle once or twice to stabilize ride height.	______	______
4. Inflated tires to manufacturer's specifications and vehicle load.	______	______
5. Checked trunk or storage area for unusual load not ordinarily carried in vehicle; removed if necessary.	______	______
6. Removed trim or bezels as necessary to gain access to aiming screws.	______	______
7. Checked headlamps and supports for loose or wobbly mounts, and corrected as necessary.	______	______
8. Attached and adjusted headlamp aimer according to equipment manufacturer's instructions.	______	______
9. Adjusted headlamps by turning screws in or out and set according to local/state requirements and instructions for the aimer.	______	______
10. Made final adjustment at each aiming screw by tightening to eliminate lash which can cause change in setting from bump or vibration.	______	______
11. Removed aimer and reattached previously removed trim or bezels.	______	______

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 141

TASK: R and R dimmer switch.

STANDARD OF PERFORMANCE OF TASK:

Replacement switch must be fastened securely in place of the original and activate high and low beams as designed.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Dimmer switch
Steering wheel puller.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize and use a steering wheel puller.

RESOURCES:

1. **Chevrolet Manual.** 1981, pp. 3-34-3-4.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when dealing with electrical equipment.
2. Explain the location of the dimmer switch.
3. Demonstrate how to remove the steering wheel.
4. Draw and discuss the wiring diagram of a dimmer switch.
5. Explain how to test a dimmer switch.
6. Show and discuss various types of dimmer switches.

PERFORMANCE OBJECTIVE 141

CRITERION-REFERENCED MEASURE:

Questions:

1. The ___________ must be removed to gain access to same dimmer switch.
2. Before attempting to remove the dimmer switch you must ___________ the switch from the electrical circuit.
3. One type dimmer switch has ___________ electrical wires.

Answers:

1. Steering wheel
2. Disconnect
3. Three

Practical Application:

R and R dimmer switch.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 141 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 141 EVALUATION

PERFORMANCE TEST FOR R AND R DIMMER SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Deactivated dimmer switch electrical circuit.	______	______
2. Gained access to dimmer switch by referring to manufacturer's instructions on disassembling steering column as necessary.	______	______
3. Loosened and disconnected wiring at dimmer switch.	______	______
4. Loosened and removed dimmer switch attaching bolts.	______	______
5. Removed dimmer switch.	______	______
6. Positioned new dimmer switch into original location.	______	______
7. Installed and tightened dimmer switch mounting screws.	______	______
8. Reattached and tightened electrical connections.	______	______
9. Activated headlamp circuit and operated dimmer switch to verify correct operations.	______	______
10. Reinstalled all parts previously removed to gain access to switch.	______	______

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 142

TASK: R and R turn signal switch.

STANDARD OF PERFORMANCE OF TASK:

New switch must be positioned in same location as original and light circuit activated by switch must operate in sequence to vehicle manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsyivania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Turn signal switch
Steering wheel puller.

ENABLING OBJECTIVES:

1. Use Standard Tool Kit.
2. Recognize and use steering wheel puller.

RESOURCES:

1. **Chevrolet Manual, 1981.** pp. 304 4-7.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical equipment.
2. Demonstrate how to remove a steering wheel.
3. Explain how a turn signal switch works.
4. Discuss the wiring diagram of a turn signal switch.
5. Demonstrate how to remove the wires from a turn signal switch.

PERFORMANCE OBJECTIVE 142

CRITERION-REFERENCED MEASURE:

Questions:

1. The steering wheel must be removed before the __________ switch can be removed.
2. The wires must have the ___________ over the wires in the steering column.
3. The wires are identified by the proper __________.

Answers:

1. Turn signal
2. Protectors
3. Color

Practical Application:

R and R turn signal switch.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 142 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 142 EVALUATION

PERFORMANCE TEST FOR R AND R TURN SIGNAL SWITCH

____

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Deactivated turn signal switch electrical circuit.	________	________
2. Gained access to turn signal switch by referring to vehicle manufacturer's instructions and disassembling steering column as necessary.	________	________
3. Loosened and disconnected wiring at turn signal switch.	________	________
4. Loosened and disconnected turn signal switch attaching bolts.	________	________
5. Removed turn signal switch assembly.	________	________
6. Positioned new turn signal switch assembly into original location.	________	________
7. Installed and tightened turn signal switch mounting screws.	________	________
8. Reattached and tightened electrical connections.	________	________
9. Activated various signal circuits with turn signal switch to verify correct operation.	________	________
10. Reinstalled all parts which were previously removed to gain access to turn signal switch.	________	________

APPROVED: Yes _____ No ______

____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 143

TASK: Adjust back-up light switch.

STANDARD OF PERFORMANCE OF TASK:

Back-up lights must operate while transmission is in reverse with no dimming or flickering and lights must not work in any other transmission position.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Test light.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Use standard test light.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** p. 304.

TEACHING ACTIVITIES:

1. Discuss how a back-up light switch works.
2. Explain how to adjust a switch using a test light.
3. Draw and discuss the wiring diagram at a back-up light switch.
4. Demonstrate how to adjust a back-up light switch.
5. Explain safety rules to follow when working with electricity.

PERFORMANCE OBJECTIVE 143

CRITERION-REFERENCED MEASURE:

Questions:

1. What operates the back-up light switch?
2. Back-up lights should work only in __________ gear.
3. A __________ is used to adjust a back-up light switch.

Answers:

1. Gear shift
2. Reverse
3. Test light

Practical Application:

Adjust back-up light switch.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 143 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 143 EVALUATION

PERFORMANCE TEST FOR ADJUSTING BACK-UP LIGHT SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Attached test light lead to good ground connection near switch.		
2. Activated back-up light circuit.		
3. Probed switch terminal which feeds back-up lights.		
4. Adjusted switch so test light will light only while transmission is in reverse.		
5. Disconnected and removed test light.		

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 144

TASK: R and R back-up light switch.

STANDARD OF PERFORMANCE OF TASK:

New switch must be securely attached, positioned in same location as original and all electrical connections must be clean and tight. Switch must operate back-up lights when transmission is in reverse gear only.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Back-up light switch.

ENABLING OBJECTIVES:

1. Use tools in a standard tool kit.
2. Recognize a back-up light switch.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** p. 304.

TEACHING ACTIVITIES:

1. Discuss the safety rules to follow when working with electrical equipment.
2. Explain how a back-up light switch works.
3. Demonstrate how to R and R a switch.
4. Explain how to use a test light to adjust a switch.
5. Draw and discuss the wiring diagram of a back-up light switch.

PERFORMANCE OBJECTIVE 144

CRITERION-REFERENCED MEASURE:

Questions:

1. Where is the back- up light switch located?
2. When the transmission is in reverse the switch must be ___________ to operate.
3. After replacing the back-up light switch it must be ___________.

Answers:

1. Steering column
2. Closed
3. Adjusted

Practical Application:

R and R back-up light switch.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 144 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 144 EVALUATION

PERFORMANCE TEST FOR R AND R BACK-UP LIGHT SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Deactivated back-up light electrical circuit.		
2. Gained access to back-up light switch.		
3. Loosened and removed back-up light switch attaching bolts.		
4. Loosened and removed back-up light switch attaching bolts.		
5. Removed back-up light switch assembly.		
6. Positioned new back-up light switch assembly into original location.		
7. Installed and tightened back-up light switch mounting screws.		
8. Reattached and tightened electrical connections.		
9. Adjusted back-up light switch to light in reverse gear only.		
10. Activated back-up light switch circuit to verify correct operation.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 145

TASK: Adjust stoplight switch.

STANDARD OF PERFORMANCE OF TASK:

Stoplights must operate only when brakes are applied; with no dimming or flickering.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Test light.

ENABLING OBJECTIVES:

1. Use a standard tool kit.
2. Use a test light.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 300-301.

TEACHING ACTIVITIES:

1. Explain the safety rules to follow while working with electrical equipment.
2. Discuss how a stoplight switch works.
3. Draw the wiring diagram for a stoplight switch.
4. Demonstrate how to adjust a stoplight switch.
5. Explain where stoplight switch is located.

PERFORMANCE OBJECTIVE 145

CRITERION-REFERENCED MEASURE:

Questions:

1. Where is the stoplight switch located?
2. When the brake pedal is up the switch is __________.
3. A __________ is used to adjust the stoplight switch.

Answers:

1. On the brake arm
2. Open
3. Test light

Practical Application:

Adjust stoplight switch.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 145 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 145 EVALUATION

PERFORMANCE TEST FOR ADJUSTING STOPLIGHT SWITCH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Gained access to stoplight switch.	______	______
2. Attached test light lead to good ground connection near switch.	______	______
3. Activated stoplight circuit.	______	______
4. Probed switch terminal which feeds stoplights.	______	______
5. Adjusted switch so test light will light only when brakes are applied.	______	______
6. Disconnected and removed test light.	______	______

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 146

TASK: R and R horn relay.

STANDARD OF PERFORMANCE OF TASK:

Horn relay must securely be mounted and positioned as original; relay must operate when activated.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Horn relay.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize a horn relay.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 506-507.

TEACHING ACTIVITIES:

1. Discuss electrical safety rules.
2. Explain how a horn relay works.
3. Demonstrate how to R and R a horn relay.
4. Draw and discuss wirings diagram for a horn relay.
5. Explain where a horn relay is located.

PERFORMANCE OBJECTIVE 146

CRITERION-REFERENCED MEASURE:

Questions:

1. Most horn circuits use a horn ___________.
2. With a horn relay a ___________ wire is sufficient to carry the current needed to operate the relay.
3. A relay is an ___________ magnet.

Answers:

1. Relay
2. Small
3. Electro

Practical Application:

R and R horn relay.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 146 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 146 EVALUATION

PERFORMANCE TEST FOR R AND R HORN RELAY

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Deactivated horn electrical circuits.		
2. Located relay and removed parts if necessary to gain access.		
3. Loosened and disconnected electrical connections at relay.		
4. Loosened and removed horn relay attaching bolts.		
5. Removed horn relay assembly.		
6. Positioned new horn relay into original location.		
7. Installed and tightened horn relay mounting screws.		
8. Reattached and tightened electrical connections.		
9. Activated horn circuit to verify correct operation of relay.		
10. Reinstalled all parts previously removed to gain access to horn relay.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 147

TASK: R and R horn.

STANDARD OF PERFORMANCE OF TASK:

Horn must operate when it receives voltage from relay and be securely mounted in position.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Horn.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize a horn.

RESOURCES:

Crouse. **Electronic and Electrical Equipment,** pp. 306-309.

TEACHING ACTIVITIES:

1. Discuss safety procedures to follow when working with electrical equipment.
2. Discuss how a horn works.
3. Draw a wiring diagram of a horn circuit.
4. Demonstrate how to R and R a horn.
5. Discuss one and two wire horns.

PERFORMANCE OBJECTIVE 147

CRITERION-REFERENCED MEASURE:

Questions:

1. Automotive horns are of the ___________ type.
2. Horns are often used in ___________.
3. A loose mounting of a horn will cause a poor ___________ and affect the horn tone.

Answers:

1. Vibrating
2. Pairs
3. Ground

Practical Application:

R and R horn.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 147 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 147 EVALUATION

PERFORMANCE TEST FOR R AND R HORN

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located horn and removed parts to gain access.		
2.	Loosened and disconnected electrical connections at horn.		
3.	Loosened and removed horn attaching bolts.		
4.	Removed horn assembly.		
5.	Positioned new horn assembly into original location.		
6.	Installed and tightened horn assembly mounting screws.		
7	Reattached and tightened electrical connections.		
8.	Activated horn circuits to verify operation.		
9.	Reinstalled all parts previously removed to gain access to horn assembly.		

APPROVED: Yes ___ No ___

Evaluator's Signature Date

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 148

TASK: R and R windshield wiper motor.

STANDARD OF PERFORMANCE OF TASK:

Motor must be positioned and fastened securely with all electrical connections clean and tight.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Windshield wiper motor.

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Recognize wiper motor.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 324-325.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical equipment.
2. Explain how wiper system works.
3. Demonstrate how to R and R a wiper motor.
4. Discuss wiring diagram of wiper motor.
5. Explain speed control of wiper motor.

PERFORMANCE OBJECTIVE 148

CRITERION-REFERENCED MEASURE:

Questions:

1. Most wiper motors are ___________ speed units.
2. The ___________ switch automatically stops the wipers in the down position.
3. If the wiper motor stalls the circuit ___________ temporarily interrupts motor current.

Answers:

1. Two
2. Park
3. Breaker

Practical Application:

R and R windshield wiper motor.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 148 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 148 EVALUATION

PERFORMANCE TEST FOR R AND R WINDSHIELD WIPER MOTOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Deactivated windshield wiper electrical circuit.		
2. Removed items as necessary to locate and gain access to windshield wiper motor.		
3. Loosened and removed nut securing wiper linkage to motor.		
4. Loosened and disconnected electrical wiring.		
5. Loosened and removed braces, brackets and hose attached to wiper motor.		
6. Loosened and removed screws securing wiper motor to vehicle.		
7. Removed wiper motor from vehicle.		
8. Positioned new wiper motor into original position.		
9. Installed and tightened mounting screws.		
10. Reattached electrical connections.		
11. Reattached brackets, braces and hoses.		
12. Reattached wiper linkage and adjusted if necessary.		
13. Activated wiper motor to verify correct operation and speeds.		
14. Reattached all parts previously removed to gain access to wiper motor.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 149

TASK: R and R windshield washer motor.

STANDARD OF PERFORMANCE OF TASK:

Washer motor must be positioned and fastened securely with all electrical connections clean and tight, and nozzles must supply sufficient amount of fluid to clean windshield.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Windshield washer motor
Washer solvent
Washer nozzle cleaning tool.

ENABLING OBJECTIVES:

1. Use tool in a standard tool kit.
2. Recognize and use a nozzle cleaning tool.

RESOURCES:

Crouse. **Electronic and Electrical Equipment,** pp. 324-325.

TEACHING ACTIVITIES:

1. Explain how a windshield washer is connected to a windshield wiper system.
2. Draw and discuss wirings diagram of a washer system.
3. Demonstrate how to test the electrical part of a washer system.
4. Explain the types of washer solvents used in a windshield washing system.
5. Demonstrate how to clean fluid reservoir and filter screen.

PERFORMANCE OBJECTIVE 149

CRITERION-REFERENCED MEASURE:

Questions:

1. The wash switch is part of the __________ switch.
2. The windshield washer sends a squirt of washing fluid through __________ to the wiper arms.
3. Contaminated washer fluid will cause the pick up tube to __________.

Answers:

1. Wiper
2. Tubes
3. Stop up

Practical Application:

R and R windshield washer motor.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 149 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 149 EVALUATION

PERFORMANCE TEST FOR R AND R WINDSHIELD WASHER MOTOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Deactivated windshield washer motor electrical circuit.		
2. Removed items as necessary to locate and gained access to windshield washer motor.		
3. Loosened and disconnected electrical wiring.		
4. Loosened and removed hoses attached to windshield washer motor.		
5. Loosened and removed screws attaching motor to vehicle.		
6. Removed washer motor from vehicle.		
7. Positioned new washer motor into original position.		
8. Referred to manufacturer's instructions if washer unit is part of wiper until assembly.		
9. Installed and tightened mounting screws.		
10. Inspected and reattached electrical connections.		
11. Cleaned washer fluid reservoir and filter screen if contaminated.		
12. Reattached washer hoses.		
13. Activated washer motor to verify correct operation.		
14. Cleaned and adjusted washer nozzles to provide correct spray pattern on windshield.		
15. Reattached all parts previously removed to gain access to washer motor.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 150

TASK: Test instrument gauges.

STANDARD OF PERFORMANCE OF TASK:

Test must detect any gauge malfunctions.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Manufacturer's gauge diagnosis manuals
Manufacturer's specified testing equipment.

ENABLING OBJECTIVES:

1. Use tools in a standard tool kit.
2. Recognize and use a manufacturer's manual.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 314-323.

TEACHING ACTIVITIES:

1. Explain the electron theory.
2. Discuss how a gauge works.
3. Demonstrate how a voltmeter works.
4. Explain how to test a sending unit.
5. Demonstrate how to check a meter or gauge.

PERFORMANCE OBJECTIVE 150

CRITERION-REFERENCED MEASURE:

Questions:

1. Most instruments are connected to a __________ circuit.
2. A sending unit is like a __________ resistor.
3. A __________ sending unit wire will cause a gauge to read its maximum.

Answers:

1. Printed
2. Variable
3. Grounded

Practical Application:

Test instrument gauges.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 150 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 150 EVALUATION

PERFORMANCE TEST FOR TESTING INSTRUMENT GAUGES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to instrument gauge wiring.		
2. Attached test light lead to ground.		
3. Turned ignition on and probed gauge terminal receiving voltage from battery.		
4. Checked battery feed circuit wiring to gauge terminal for open or short circuit, if test light does not light.		
5. Disconnected wire at gauge sending unit; note gauge movement.		
6. Grounded sending unit wire; noted gauge movement.		
7. Compared with manufacturer's specifications for gauge operation during test or proceeded using manufacturer's specific gauge diagnosis procedures.		
8. Disconnected test light.		
9. Reattached any parts removed or disassembled to conduct test.		
10. Noted results on work order.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 151

TASK: R and R instrument gauges.

STANDARD OF PERFORMANCE OF TASK:

Gauges must operate by indicating engine function being monitored; gauge functions must meet manufacturer's specifications and not give false readings.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Gauge.

ENABLING OBJECTIVES:

1. Use tools in a standard tool kit.
2. Recognize and use manufacturer's manual.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 314-326.

TEACHING ACTIVITIES:

1. Explain how various gauges work on cars.
2. Explain how to check out gauge circuits.
3. Discuss what to do if a gauge doesn't work.
4. Demonstrate how to R and R gauge panel.
5. Discuss safety procedures to follow when working with electrical components.

PERFORMANCE OBJECTIVE 151

CRITERION-REFERENCED MEASURE:

Questions:

1. Most automobiles have ___________ electrically operated gauges.
2. Electrically operated gauges are of either the balancing coil or the ___________ type.
3. Gauges are connected with separate wires or a ___________ circuit.

Answers:

1. Four
2. Thermostatic
3. Printed

Practical Application:

R and R instrument gauges.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 151 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 151 EVALUATION

PERFORMANCE TEST FOR R AND R INSTRUMENT GAUGES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Loosened and removed trim and lenses in front of gauge; referred to manufacturer's instructions as necessary.		
2.	Located and gained access to instrument gauge wiring.		
3.	Disconnected battery ground cable.		
4.	Loosened and disconnected gauge wiring.		
5.	Loosened and removed screws securing gauge.		
6.	Removed gauge from instrument panel.		
7.	Positioned new gauge into original location.		
8.	Installed and tightened gauge mounting screws.		
9.	Reattached electrical connections.		
10.	Reconnected battery and verified correct gauge operation.		
11.	Reinstalled lenses and trim previously removed.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 152

TASK: Test sending units.

STANDARD OF PERFORMANCE OF TASK:

Test must detect any defects or deviations from manufacturer's specifications for operation.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Volt-ohmmeter
Digital voltmeter.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize and use volt-ohmmeter.

RESOURCES:

1. Crouse. **Electronic and Electrical Equipment,** pp. 314-323.

TEACHING ACTIVITIES:

1. Explain the safety rules to follow while working with electrical equipment.
2. Discuss with student(s) how sending units work.
3. Demonstrate how to use a volt-ohmmeter to test a sending unit.
4. Draw and discuss the wiring schematic for a sending unit circuit.
5. Explain the two types of sending units.

PERFORMANCE OBJECTIVE 152

CRITERION-REFERENCED MEASURE:

Questions:

1. As the temperature of an engine temperature sending unit goes up, the resistance of the unit goes ____________.
2. The oil pressure sending unit will check ____________ with the engine not running.
3. An ____________ is used to check a sending unit.

Answers:

1. Up
2. Closed
3. Ohmmeter

Practical Application:

Test sending units.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 152 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 152 EVALUATION

PERFORMANCE TEST FOR TESTING SENDING UNITS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to sending unit.		
2. Referred to vehicle manufacturer's diagnosis procedure.		
3. Disconnected wiring from sending unit.		
4. Set volt-ohmmeter or digital voltmeter and connected negative lead to ground according to manufacturer's procedures.		
5. Probed sending unit terminal with other hand.		
6. Noted reading and repeated test with engine in mode of operation or temperature to supply different reading for comparative purposes.		
7. Compared readings with manufacturer's specifications.		
8. Reconnected electrical connections.		
9. Reattached all parts removed previously to gain access to sending unit.		
10. Noted results on work order.		

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 153

TASK: R and R sending units.

STANDARD OF PERFORMANCE OF TASK:

Sending unit must give manufacturer's specified output without loose or crossed threads, leaks or loose electrical connections.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Sending Units
Thread sealing compound.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret manufacturer's manual.

RESOURCES:

1. **Chevrolet Service Manual,** 1981, p. 8-C-2-9.

TEACHING ACTIVITIES:

1. Explain the safety rules to follow when working with electrical components.
2. Discuss procedures to remove sending unit.
3. Explain how sending unit is to be tested according to the service manual.
4. Demonstrate how to check a sending unit.
5. Draw wiring connections of sending units.

PERFORMANCE OBJECTIVE 153

CRITERION-REFERENCED MEASURE:

Questions:

1. An oil pressure sending unit will have ____________ wire attached.
2. To gain access to the fuel sending unit, the ____________ must be removed.
3. Fuel sending units can be checked with an ____________.

Answers:

1. One
2. Tank
3. Ohmmeter

Practical Application:

R and R sending unit.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 153 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 153 EVALUATION

PERFORMANCE TEST FOR R AND R SENDING UNITS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Located and gained access to sending unit with ignition off.	________	________
2. Loosened and removed electrical connections at sending unit.	________	________
3. Partially drained cooling system if temperature sending unit is being replaced.	________	________
4. Referred to manufacturer's instructions for removal of gas tank sending units.	________	________
5. Loosened and removed sending unit and associated attachment hardware.	________	________
6. Coated new sending unit threads with sealant compound if being installed in a cavity containing engine fluids.	________	________
7. Installed sending unit and tightened securely without over tightening or stripping threaded sending units.	________	________
8. Reattached electrical connections.	________	________
9. Reinstalled any parts previously removed to gain access to sending unit.	________	________
10. Operated vehicle to verify correct operation of sending unit according to manufacturer's specifications.	________	________

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 154

TASK: Test warning lamps.

STANDARD OF PERFORMANCE OF TASK:

Test procedures must detect any malfunctions of warning lamps and be performed according to manufacturer's recommendations procedures.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Use test light.

RESOURCES:

1. **Chevrolet Manual,** 1981, p. 82-2.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical units.
2. Explain how warning lamps work.
3. Discuss instrument panel diagnosis listed in the service manual.
4. Demonstrate how to check light bulbs.
5. Draw and discuss wiring diagrams for instrument panel.

PERFORMANCE OBJECTIVE 154

CRITERION-REFERENCED MEASURE:

Questions:

1. Instrument panels use a ___________ circuit board.
2. With the ignition switch on, and the engine off the oil lamp will be ___________ if the circuit is working.
3. Apply ___________ to lamp terminals to detect inoperative lamp.

Answers:

1. Printed
2. Lighted
3. Voltage

Practical Application:

Test warning lamps for malfunctions.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 154 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 154 EVALUATION

PERFORMANCE TEST FOR TESTING WARNING LAMPS FOR MALFUNCTIONS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to warning lamps wiring.		
2.	Turned ignition on and noted if lamp lights.		
3.	Referred to manufacturer's instructions for different procedure if lamp does not operate.		
4.	Checked wiring and connections at back of lamp if it did not operate during test.		
5.	Disconnected electrical connections at warning lamp terminals.		
6.	Applied battery voltage to lamp terminals to detect inoperative lamp.		
7.	Attached test light lead to ground and probed warning lamp battery feed wire for voltage.		
8.	Reconnected test light lead to positive battery terminal or equivalent and probed sending unit feed wire terminal.		
9.	Referred to sending unit diagnosis if test light does not come on.		
10.	Reconnected electrical connections at warning lamp terminal.		
11.	Reattached any parts previously removed to gain access to warning lamps.		
12.	Noted results on work order.		

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING BASIC AUTOMOTIVE ELECTRICAL SYSTEM

PERFORMANCE OBJECTIVE 155

TASK: R and R warning lamps.

STANDARD OF PERFORMANCE OF TASK:

Lamp must indicate vehicle malfunction or functions being monitored must not give false indications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Warning lamp(s).

ENABLING OBJECTIVES:

1. Use tools in standard tool kits.
2. Read and interpret service manuals.

RESOURCES:

1. **Chevrolet Service Manual,** 1981, p. 82-6-7.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical components.
2. Review instructions with student on how to R and R instrument panel.
3. Explain how to check light bulb with an ohmmeter.
4. Demonstrate how to remove a bulb from a socket.
5. Explain how a warning light works.

PERFORMANCE OBJECTIVE 155

CRITERION-REFERENCED MEASURE:

Questions:

1. A lamp can be checked with an ___________.
2. Warning lamps use a ___________ circuit instead of wires.
3. Refer to ___________ ___________ for instructions on gaining access to warning lamps.

Answers:

1. Ohmmeter
2. Printed
3. Service manual

Practical Application:

R and R warning lamps.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 155 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 155 EVALUATION

PERFORMANCE TEST FOR R AND R WARNING LAMPS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Loosened and removed trim and lenses to gain access to warning lamps.	______	______
2. Deactivated warning lamp circuits.	______	______
3. Loosened and removed screws securing warning lamp(s).	______	______
4. Removed lamp(s) from instrument panel.	______	______
5. Positioned new lamp(s) into original location.	______	______
6. Installed and tightened mounting screws.	______	______
7. Reattached electrical connections.	______	______
8. Activated circuit to verify correct operation of warning lamps.	______	______
9. Reattached all parts previously removed to gain access to warning lamp(s).	______	______

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 156

TASK: Test cruise control servo.

STANDARD OF PERFORMANCE OF TASK:

All failures of servo unit must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Hand operated vacuum pump.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Use hand vacuum pump.

RESOURCES:

1. **Chevrolet Service Manual,** 1981, pp. 8A-92, 8A-93.

TEACHING ACTIVITIES:

1. Explain how a cruise control system works.
2. Discuss what the servo does in the system.
3. Demonstrate how to check the servo with a vacuum pump.
4. Discuss reaction of a malfunctioning servo unit.
5. Draw and discuss vacuum line diagram for a cruise control unit.

PERFORMANCE OBJECTIVE 156

CRITERION-REFERENCED MEASURE:

Questions:

1. A cruise control servo operates off engine ___________.
2. A hand ___________ ___________ is used to test a servo.
3. A bad servo will not hold ___________ inches of vacuum.

Answers:

1. Vacuum
2. Vacuum pump
3. 15

Practical Application:

Test cruise control servo for malfunction.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 156 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 156 EVALUATION

PERFORMANCE TEST FOR TESTING CRUISE CONTROL SERVO FOR MALFUNCTION

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to cruise control servo.		
2. Disconnected servo linkage and hose from servo.		
3. Attached vacuum pump to servo vacuum fitting.		
4. Applied 10-15 inches of vacuum to servo, and noted operation of diaphragm.		
5. Discarded servo if it does not move when vacuum applied.		
6. Applied again 10-15 inches of vacuum and noted if servo will maintain vacuum.		
7. Discarded servo if leakage is indicated.		
8. Removed vacuum pump and reinstalled hoses and linkage.		
9. Reinstalled all parts previously removed to gain access to servo.		
10. Referred to manufacturer's test procedures if servo is electrically operated.		
11. Noted results on work order.		

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 157

TASK: Adjust cruise control system.

STANDARD OF PERFORMANCE OF TASK:

While car is in operation and cruise control engaged, vehicle must operate at set speed with no jerking or surging; cruise control must disengage with slightest touch on brake pedal.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Hand operated vacuum pump.

ENABLING OBJECTIVES:

1. Use tools in a standard tool kit.
2. Use hand vacuum pump.

RESOURCES:

1. **Chevrolet Service Manual,** 1981, pp. 8A-92, 8A-93.

TEACHING ACTIVITIES:

1. Explain how a cruise control works.
2. Discuss each part of control unit.
3. Have student(s) review circuit operation for type to be checked.
4. Demonstrate operation of cruise unit.
5. Demonstrate how to use hand vacuum pump to operate servo.

PERFORMANCE OBJECTIVE 157

CRITERION-REFERENCED MEASURE:

Questions:

1. A cruise control unit operates above ___________ miles per hour.
2. Servo chain must have a minimum ___________ in linkage.
3. Check vacuum controls for leaks or ___________.

Answers:

1. 30
2. Slack
3. Restrictions

Practical Application:

Test cruise control servo for failures.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 157 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 157 EVALUATION

PERFORMANCE TEST FOR TESTING CRUISE CONTROL SERVO FOR FAILURES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Gained access to servo linkage and inspected for loose or binding parts.		
2.	Determined play in linkage and compared with manufacturer's specifications.		
3.	Adjusted if necessary by referring to manufacturer's manual for specific instructions.		
4.	Gained access to cruise release switch(es) at brake pedal linkage under dash.		
5.	Disconnected vacuum line from switch.		
6.	Attached vacuum pump to fitting on switch.		
7.	Applied vacuum to switch and adjusted switch in bracket so vacuum is released with slightest movement of brake pedal.		
8.	Removed vacuum pump and reattached line to switch.		
9.	Removed electrical connections from electrical release switch.		
10.	Attached ohmmeter leads to terminal on switch.		
11.	Adjusted switch so ohmmeter shows open circuit with the slightest movement of brake pedal.		
12.	Reattached electrical connections.		
13.	Road tested car and operated cruise control system.		
14.	Noted amount of variation, if any, between the speed cruise control is set for, and the speed at which the car is controlled.		

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
15. Located and gained access to cruise control transducer.	________	________
16. Checked cruise control system for pinched or leaking hoses before making adjustments to transducer.	________	________
17. Adjusted cruise speed zeroing to eliminate variation detected in road test. (Refer to manufacturer's service manual for specific procedures).	________	________

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 158

TASK: R and R cruise control. components.

STANDARD OF PERFORMANCE OF TASK:

All parts must be installed and function as original; system must operate and function according to manufacturer's specifications for control of speed variation.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Cruise control component(s) being replaced.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize cruise control components.

RESOURCES:

1. **Chevrolet Service Manual,** 1981, p. 8A-92.

TEACHING ACTIVITIES:

1. Discuss the purpose of each component of a cruise control.
2. Have student(s) review circuit operation of components in service manual.
3. Explain how a cruise control works.
4. Demonstrate how to adjust various cruise control components.
5. Draw and explain electrical circuit for control unit.

PERFORMANCE OBJECTIVE 158

CRITERION-REFERENCED MEASURE:

Questions:

1. The ___________ is electrically engaged and disengaged.
2. The ____________ operates the throttle when the system is activated.
3. The cruise control unit is disengaged by ___________ the brake pedal.

Answers:

1. Transducer
2. Servo
3. Depressing

Practical Application:

R and R cruise control.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 158 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 158 EVALUATION

PERFORMANCE TEST FOR R AND R CRUISE CONTROL

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to component being removed.		
2. Loosened and disconnected speedometer cables, hoses or electrical connectors as used.		
3. Loosened and removed any braces or brackets supporting unit.		
4. Loosened and removed screws or bolts securing component on vehicle.		
5. Removed component from vehicle.		
6. Installed new component in original position.		
7. Reinstalled and tightened mounting bolts.		
8. Reinstalled brackets and braces previously removed.		
9. Reconnected speedometer cables, hoses or electrical connectors.		
10. Operated cruise control system and made adjustments to system as required.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 159

TASK: Test automatic alarm system.

STANDARD OF PERFORMANCE OF TASK:

Any defects in alarm system causing failure of alarm to activate or to activate falsely must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Alarm system manuals.

ENABLING OBJECTIVES:

1. Use ignition switch key.
2. Read and interpret service manual.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 15.29--15.34

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical components.
2. Describe how various alarm systems work.
3. Demonstrate how to arm an alarm.
4. Draw and discuss the wiring diagram of various alarm systems.
5. Demonstrate how to disarm various alarm systems.

PERFORMANCE OBJECTIVE 159

CRITERION-REFERENCED MEASURE:

Questions:

1. An alarm system shut down is accomplished by __________ the door.
2. Once the system is set off it will continue to operate for approximately __________ minutes.
3. The alarm pulsates the vehicles __________ at a rate of 50 cycles a minute.

Answers:

1. Unlocking
2. 3-7
3. Horn

Practical Application:

Test automatic alarm system for defects.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 159 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 159 EVALUATION

PERFORMANCE TEST FOR TESTING AUTOMATIC ALARM SYSTEM FOR DEFECTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Lowered driver's window.		
2. Turned ignition off and removed keys.		
3. Locked all interior doors except driver's door.		
4. Exited car, closed driver's door and locked with key. (Referred to alarm system operator's manual to activate system if different procedure was used).		
5. Reached into car through open window and opened door with interior controls.		
6. Noted that activated alarm means system is operating correctly.		
7. Deactivated system by turning off master switch or by unlocking driver's door with key.		
8. Referred to manufacturer's diagnostic service manual for any malfunctions of the system.		
9. Noted results on work order.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 160

TASK: R and R automatic alarm system components.

STANDARD OF PERFORMANCE OF TASK:

Replacement components must be securely installed and function according to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Alarm system manuals
Alarm system components.

ENABLING OBJECTIVES:

1. Use tools in a standard tool kit.
2. Read and interpret shop manual.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 15.29 -- 15.34

TEACHING ACTIVITIES:

1. Explain how an alarm system works.
2. Discuss safety rules to follow when working with electrical systems.
3. Draw and discuss the wiring diagram of various alarm systems.
4. Demonstrate how each switch and controller operates.
5. Have student review diagnosis chart and discuss.

PERFORMANCE OBJECTIVE 160

CRITERION-REFERENCED MEASURE:

Questions:

1. The __________ receives all signals to set off the alarm.
2. When the last door is closed the system is __________.
3. A complete testing of all __________ is required in order to detect problems.

Answers:

1. Controller
2. Armed
3. Circuits

Practical Application:

R and R automatic alarm system components.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 160 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 160 EVALUATION

PERFORMANCE TEST FOR R AND R AUTOMATIC ALARM SYSTEM COMPONENTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Located and gained access to components being replaced referring to appropriate manuals.	______	______
2. Loosened and disconnected battery ground cable.	______	______
3. Loosened and disconnected all electrical connections to unit being serviced.	______	______
4. Loosened and removed all brackets and braces supporting unit.	______	______
5. Loosened and removed component mounting screws.	______	______
6. Removed component and placed new part in original position.	______	______
7. Reinstalled and tightened mounting screws.	______	______
8. Reattached any brackets or braces previously removed.	______	______
9. Reattached electrical connections and adjusted sensitivity of alarm sensors.	______	______
10. Reinstalled parts previously removed to gain access to unit.	______	______
11. Reattached battery cables.	______	______

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 161

TASK: Inspect radio speaker.

STANDARD OF PERFORMANCE OF TASK:

Any malfunction of the speaker must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit.

ENABLING OBJECTIVES:

1. Use standard tool kit.
2. Read and interpret Radio Services Manual.

RESOURCES:

1. **Chevrolet Service Manual,** 1981, p. 8A.88.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical components.
2. Draw and discuss wiring of radio speaker.
3. Demonstrate how to check radio speaker for distortion.
4. Demonstrate how a distorted speaker sounds.
5. Have student review **Chevrolet Service Manual,** 1981, p. 8A.88 for access.

PERFORMANCE OBJECTIVE 161

CRITERION-REFERENCED MEASURE:

Questions:

1. Listen for distortion or __________ in a bad speaker.
2. Sound should be checked at moderate volume with both full bass and full __________.
3. Speaker connections should be made out between the speaker and the __________.

Answers:

1. Rattle
2. Treble
3. Radio

Practical Application:

Inspect radio speaker for malfunction.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 161 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 161 EVALUATION

PERFORMANCE TEST FOR INSPECTING RADIO SPEAKER FOR MALFUNCTION

Student's Name ______________________________ Date ______________

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Operated radio with moderate volume with both full bass and full treble.		
2. Listened for speaker rattle or distortion.		
3. Located and gained access to radio speaker.		
4. Inspected speaker cone for obvious damage.		
5. Flexed cone gently back and forth with fingers and listened for abrasion of speaker coil misalignment.		
6. Compared sound with a known good speaker if unsure.		
7. Replaced speaker if tests indicate defective sound quality.		
8. Reinstalled speaker and parts previously removed to gain access.		
9. Noted results on work order.		

APPROVED: Yes _____ No _____

Evaluator's Signature ______________________________ Date ______________

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 162

TASK: R and R radio speaker.

STANDARD OF PERFORMANCE OF TASK:

New speaker must be securely mounted without damage to cone or frame assembly and operate with no rattle or vibration.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Radio speaker.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret radio speaker diagram.

RESOURCES:

1. **Chevrolet Service Manual,** 1981, p. 8A.88.

TEACHING ACTIVITIES:

1. Explain safety precautions to take when working with electrical components.
2. Have student(s) review procedure for removing the speaker in the service manual.
3. Explain speaker polarity.
4. Draw and discuss electrical wiring diagram.
5. Demonstrate how to hook up electrical wires to a speaker.

PERFORMANCE OBJECTIVE 162

CRITERION-REFERENCED MEASURE:

Questions:

1. Correct access to speaker can be found in the ___________.
2. To prevent damage to the radio when installing a speaker always remove the radio ___________.
3. Speakers have to be wired with the correct ___________.

Answers:

1. Service manual
2. Fuse
3. Polarity

Practical Application:

R and R radio speaker.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 162 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 162 EVALUATION

PERFORMANCE TEST FOR R AND R RADIO SPEAKER

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Located and gained access to radio speaker.		
2.	Loosened and removed speaker mounting screws.		
3.	Removed speaker and disconnected electrical connections.		
4.	Attached electrical connections to new speaker observing same polarity as when attached to original.		
5.	Installed new speaker in original position.		
6.	Installed and tightened mounting screws without distorting speaker frame by over tightening screws.		
7.	Reinstalled all parts previously removed to gain access to speaker.		

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 163

TASK: Test radio antenna.

STANDARD OF PERFORMANCE OF TASK:

Any weaknesses of antenna reception system must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Test radio antenna.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret service manual.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 12.56 --12.57

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical components.
2. Explain radio and antenna theory and operation.
3. Demonstrate how to test various antennas.
4. Demonstrate how to R and R various antennas.
5. Draw and discuss the wiring diagram of an antenna.

PERFORMANCE OBJECTIVE 163

CRITERION-REFERENCED MEASURE:

Questions:

1. ___________ signals are much shorter therefore limit the distance signals can be received.
2. To adjust antenna trim, tune in a weak station at approximately ___________ kilohertz.
3. Antenna trimmer is visually located behind the ___________ control.

Answers:

1. F.M.
2. 1400
3. Volume

Practical Application:

Test antenna for weaknesses.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 163 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 163 EVALUATION

PERFORMANCE TEST FOR TESTING ANTENNA FOR WEAKNESSES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Operated radio on AM and FM band (if applicable) and checked for a strength and number of stations received.		
2. Adjusted antenna trimmer.		
3. Compared results with accepted standard for locale.		
4. Located and gained access to antenna plug at back of radio and disconnected.		
5. Attached a known good antenna to radio and compared that to original reception.		
6. Discarded old radio antenna if test antenna showed substantial improvement in reception.		
7. Noted results on work order.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 164

TASK: R and R radio antenna.

STANDARD OF PERFORMANCE OF TASK:

Antenna must be mounted securely and positioned/angled properly; lead-in connections must be clean and tight.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Radio antenna.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret service manual.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 12.56 --12.60.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical components.
2. Have student(s) read **Cadillac Shop Manual,** 1976, pp. 12.56-12.60 or R and R radio.
3. Demonstrate how to remove antenna from vehicle body.
4. Demonstrate how to fish antenna lead-in and out of car.
5. Discuss how to verify radio reception.

PERFORMANCE OBJECTIVE 164

CRITERION-REFERENCED MEASURE:

Questions:

1. For safety always disconnect the __________ before attempting to work on electrical components.
2. To facilitate installation of antenna cable attach a __________ to the radio end of the cable.
3. Always operate the __________ to verify reception.

Answers:

1. Battery
2. Wire
3. Radio

Practical Application:

R and R radio antenna.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 164 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 164 EVALUATION

PERFORMANCE TEST FOR R AND R RADIO ANTENNA

Student's Name   Date

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to antenna connection on radio and disconnected.		
2. Separated antenna wire from other harnesses, etc. up to grommet where wire passes through vehicle body.		
3. Loosened and removed grommet.		
4. Attached securely 3 to 4 feet pieces of mechanic's wire to end of lead-in wire to facilitate installation of new antenna.		
5. Located and gained access to antenna mounting.		
6. Disconnected antenna mounting screws, brackets, braces, etc.		
7. Removed antenna and lead-in from vehicle.		
8. Left end of "fish" wire inside vehicle.		
9. Removed lead-in from end of "fish" wire.		
10. Attached outside end of "fish" wire to new antenna lead-in.		
11. Worked lead-in through holes in body routing as original by pulling on "fish" wire from inside of car.		
12. Installed new antenna in original position.		
13. Reinstalled all brackets, braces and screws attaching antenna to vehicle.		
14. Slid grommet over lead-in wire and reinstalled hole in body.		

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
15.	Reroute lead-in to radio and reattached at antenna socket on radio.	________	________
16.	Reinstalled parts previously removed to gain access to back of radio.	________	________
17.	Operated radio to verify reception.	________	________

APPROVED: Yes _____ No ______

Evaluator's Signature Date

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 165

TASK: Trim radio antenna.

STANDARD OF PERFORMANCE OF TASK:

Radio trimmer must be adjusted to maximum signal strength available from radio.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret service manual.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, p. 12.56.

TEACHING ACTIVITIES:

1. Explain operation of a radio receiving set.
2. Discuss when an antenna needs to be trimmed.
3. Demonstrate how to trim an antenna.
4. Have student read **Cadillac Shop Manual,** 1976, p.12.56 on how to make minor adjustments of the radio.
5. Discuss safety rules to follow when working with electrical equipment.

PERFORMANCE OBJECTIVE 165

CRITERION-REFERENCED MEASURE:

Questions:

1. To trim an antenna tune the radio to __________ kilohertz.
2. Antenna adjustment is usually located behind __________ radio knob.
3. Antenna trimming should always be performed after any radio or __________ repair work.

Answers:

1. 1400
2. Right
3. Antenna

Practical Application:

Adjust radio for maximum signal strength.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 165 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 165 EVALUATION

PERFORMANCE TEST FOR ADJUSTING RADIO FOR MAXIMUM SIGNAL STRENGTH

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Turned radio on and turned for weak station near 1400 kilocycles on the AM dial.	____	____
2. Turned volume up.	____	____
3. Located and gained access to antenna trimmer adjustment screw.	____	____
4. Adjusted trimmer screw back and forth until maximum volume is obtained.	____	____
5. Set screw at peak volume.	____	____

APPROVED: Yes ___ No ___

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 166

TASK: R and R power antenna motor.

STANDARD OF PERFORMANCE OF TASK:

Antenna must extend and retract fully without binding and with no unusual noises; all electrical connections must be clean and tight.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Power antenna motor.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret shop manual.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 12.58 - 12.60.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical equipment.
2. Draw and discuss electrical wiring diagram of a power antenna.
3. Have student(s) read R and R procedure in **The Cadillac Shop Manual,** 1976, pp. 12.58 - 12.60.
4. Explain how an electrical antenna works.
5. Demonstrate how to check the operation of various power antennas.

PERFORMANCE OBJECTIVE 166

CRITERION-REFERENCED MEASURE:

Questions:

1. The ___________ must be removed off the car before the motor can be removed.
2. Electrical wires on the motor are color ___________.
3. Always check ___________ operation before reinstallation.

Answers:

1. Antenna
2. Coded
3. Motor

Practical Application:

R and R power antenna motor.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 166 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 166 EVALUATION

PERFORMANCE TEST FOR R AND R POWER ANTENNA MOTOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to power antenna motor assembly; referred to manufacturer's instructions if necessary.	______	______
2. Loosened and removed electrical connections.	______	______
3. Loosened and removed antenna lead-in wire.	______	______
4. Loosened and removed supporting brackets and braces.	______	______
5. Loosened and removed bolts, etc. attaching motor to vehicle.	______	______
6. Removed motor from vehicle.	______	______
7. Installed new motor in original position.	______	______
8. Installed and tightened mounting hardware.	______	______
9. Reattached antenna lead-in wire.	______	______
10. Reattached electrical connections.	______	______
11. Operated power antenna to verify proper operation.	______	______
12. Reinstalled all parts previously removed to gain access to antenna motor.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 167

TASK: R and R power window motor.

STANDARD OF PERFORMANCE OF TASK:

Windows must operate without binding or unusual noises and all electrical connections must be clean and tight.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Power window motor
Power window motor manual.

ENABLING OBJECTIVES:

1. Read and interpret a shop manual.
2. Use tools in a standard tool kit.

RESOURCES:

1. **Fisher Body Service Manual,** 1984, pp. 531-532.

TEACHING ACTIVITIES:

1. Discuss safety precautions to follow when working with electrical component.
2. Explain the theory of power window operation.
3. Demonstrate how to R and R the door trim panel.
4. Demonstrate how to R and R window motor.
5. Demonstrate how to use a rivet gun to replace the motor.

PERFORMANCE OBJECTIVE 167

CRITERION-REFERENCED MEASURE:

Questions:

1. The power window incorporates a 12V __________ motor.
2. Always disconnect the __________ before attempting to remove a power window motor.
3. The __________ must be removed from the door to gain access to the motor.

Answers:

1. Reversible
2. Battery
3. Trim

Practical Application:

R and R power window motor.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 167 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 167 EVALUATION

PERFORMANCE TEST FOR R AND R POWER WINDOW MOTOR

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Loosened and disconnected battery ground cable.		
2.	Loosened and removed door panel; referred to manufacturer's manual, if necessary.		
3.	Disconnected electrical wiring from motor.		
4.	Disconnected power window linkage.		
5.	Loosened and removed brackets, braces, etc. supporting motor.		
6.	Loosened and removed motor attaching screws.		
7.	Removed motor from door.		
8.	Installed new motor in original position.		
9.	Reinstalled and tightened mounting bolts and screws.		
10.	Reinstalled braces, brackets, etc. supporting motor.		
11.	Reinstalled power motor linkage.		
12.	Reconnected and tightened electrical connections.		
13.	Reconnected battery cables.		
14.	Operated car window to check for binding or excessive noise and correct, if necessary.		
15.	Reinstalled door panel.		

APPROVED: Yes ____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 168

TASK: R and R power seat components.

STANDARD OF PERFORMANCE OF TASK:

Electrical connections must be clean and tight; transmission cables must be properly routed with no binding or kinking. Wiring and cables must be routed so as not to interfere with travel of seat. Seat controls must operate in correct sequence and all control options must operate to full limits of travel without jerking or binding.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Power seat components
Power seat manual.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Recognize and use electrical trouble shooting tools.

RESOURCES:

1. **Fisher Body Service Manual,** 1984, pp. 938-939.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow while working with electrical components.
2. Discuss the various types of front seats which use power controls.
3. Demonstrate how to remove a front seat.
4. Explain how to test the controls of a power seat.
5. Have student(s) read **Fisher Body Service Manual,** 1984, pp. 938-939 on R and R power seat controls.

PERFORMANCE OBJECTIVE 168

CRITERION-REFERENCED MEASURE:

Questions:

1. The seat is removed with the ____________ and ____________ attached.
2. Detach cables from seat adjusters by squeezing ____________ plastic connectors.
3. Check operation of transmission and seat adjuster to limits of ____________ and vertical travel.

Answers:

1. Transmission motor
2. Oblong
3. Horizontal

Practical Application:

R and R power seat components.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 168 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 168 EVALUATION

PERFORMANCE TEST FOR R AND R POWER SEAT COMPONENTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to component being replaced referring to appropriate manuals.		
2. Loosened and disconnected battery cables.		
3. Loosened and disconnected all electrical connections to unit being serviced.		
4. Loosened and removed all brackets and braces supporting unit.		
5. Loosened and removed drive cables if transmission is being replaced.		
6. Loosened and removed component mounting screws		
7. Removed component and put new component in original position.		
8. Reinstalled and tightened mounting screws.		
9. Reinstalled any brackets or braces previously removed.		
10. Reattached electrical connections.		
11. Reinstalled drive cables if removed from transmission.		
12. Reinstalled all parts previously removed to gain access to unit.		
13. Reattached battery cables.		
14. Operated seat to verify correct operation.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 169

TASK: R and R cigarette lighter receptacle.

STANDARD OF PERFORMANCE OF TASK:

Lighter must operate in receptacle without excessive looseness or tightness.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
New receptacle.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret manufacturer's specifications.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 12-69.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical components.
2. Draw and discuss wiring diagram for various cigarette lighters.
3. Demonstrate how to R and R the lighter.
4. Have students read **Cadillac Shop Manual,** 1976, pp. 12-67 or assemble R and R.
5. Demonstrate how to operate cigarette lighter.

PERFORMANCE OBJECTIVE 169

CRITERION-REFERENCED MEASURE:

Questions:

1. Always disconnect the ____________ before working on electrical connections.
2. Remove lighter base from sleeve by holding sleeve and rotating ____________ base.
3. Operate lighter by ___________ in on lighter assembly.

Answers:

1. Battery
2. Lighter
3. Pressing

Practical Application:

R and R cigarette lighter receptacle.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 169 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 169 EVALUATION

PERFORMANCE TEST FOR R AND R CIGARETTE LIGHTER RECEPTACLE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Disconnected battery ground cable.		
2. Gained access to cigarette lighter receptacle at back of dash.		
3. Disconnected electrical wiring.		
4. Loosened and removed attaching screws or collar.		
5. Removed receptacle.		
6. Installed new receptacle in original position.		
7. Reinstalled and tightened mounting screws.		
8. Reattached electrical connections.		
9. Reconnected battery cable.		
10. Operated cigarette lighter to verify correct operation.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 170

TASK: Test rear defogger.

STANDARD OF PERFORMANCE OF TASK:

All defects and malfunctions or rear window defogger must be detected.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Manufacturer's diagnosis manual
Test light.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret diagnosis manual.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 15.25-15.26.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical components.
2. Explain theory of operation of various rear defoggers.
3. Have student read test procedure in **Cadillac Shop Manual,** 1976, pp. 15.25-15.26 for automobile being tested.
4. Demonstrate how to use a test light to test defogger circuit.
5. Draw and discuss the wiring diagram of various defogger circuits.

PERFORMANCE OBJECTIVE 170

CRITERION-REFERENCED MEASURE:

Questions:

1. The defogger is an ___________ heated window.
2. A non-powered __________ __________ is used to test a defogger.
3. A ___________ indicator light is illuminated whenever the defogger is operating.

Answers:

1. Electrical
2. Test light
3. Green

Practical Application:

Test rear defogger for defects and malfunctions.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 170 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 170 EVALUATION

PERFORMANCE TEST FOR TESTING REAR DEFOGGER FOR DEFECTS AND MALFUNCTIONS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Activated defogger.		
2. Grounded test light and probed defogger feed wire at rear window.		
3. Tested for voltage at defogger relay if test light does not come on.		
4. Located defogger relay and probed defogger grid for voltage.		
5. Probed relay feed wire to defogger grid for voltage.		
6. Checked voltage at fuse panel if no voltage at relay feed wire.		
7. Checked relay activation wire from dash control switch for voltage, if relay is not supplying voltage to grid.		
8. Replaced relay if voltage tests do not correspond to manufacturer's specifications.		
9. Grounded test light and once voltage is available at defogger grid probed each grid at two or more positions along grid toward grounded end of grid line.		
10. Repaired grid ground circuit if test light does not grow dimmer with successive tests of each grid line while moving toward grounded side of grid.		
11. Repaired grid lines if test light does not become dimmer with consecutive tests of any one line.		
12. Timed defogger cycling and compared to manufacturer's specifications.		
13. Noted results on work order.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 171

TASK: R and R rear defogger components.

STANDARD OF PERFORMANCE OF TASK:

Defogger must operate and cycle according to manufacturer's specifications.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
New components for rear window defogger
Defogger system manual.

ENABLING OBJECTIVES:

1. Read and interpret shop manual.
2. Use tool in standard tool kit.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 15, 26, 27.

TEACHING OBJECTIVE(S):

1. Discuss safety rules to follow when working with electrical components.
2. Have student(s) read **Cadillac Shop Manual,** 1976, pp. 15, 26, 27 on defogger.
3. Draw and discuss the wiring diagram of a window defogger.
4. Explain purpose of each component of various defogger systems.
5. Demonstrate how to test component of a defogger system.

PERFORMANCE OBJECTIVE 171

CRITERION-REFERENCED MEASURE:

Questions:

1. The defogger system is fed through a __________ amp fuse located in the fuse block.
2. The time delay relay is located on the lower __________ __________.
3. Service information pertaining to the rear window defogger is covered in the __________ manual.

Answers:

1. 25
2. Steering column
3. Body

Practical Application:

R and R defogger components.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 171 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 171 EVALUATION

PERFORMANCE TEST FOR R AND R DEFOGGER COMPONENTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to component being replaced referring to appropriate manuals.		
2. Deactivated defogger circuit.		
3. Loosened and disconnected all electrical connections to component being replaced.		
4. Loosened and removed any brackets or braces supporting component.		
5. Loosened and removed mounting screws.		
6. Removed component and placed new part in original position.		
7. Reinstalled and tightened mounting screws.		
8. Reinstalled brackets and braces previously removed.		
9. Reattached electrical connections.		
10. Reinstalled all parts previously removed to gain access to unit.		
11. Activated defogger circuit to verify correct operation.		

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 172

TASK: R and R electric door lock components.

STANDARD OF PERFORMANCE OF TASK:

All locks must operate without binding or chattering or unusual noises.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Power door lock components
Power door lock manual.

ENABLING OBJECTIVES:

1. Read and interpret electrical trouble shooting manual.
2. Use tools in standard tool kit.

RESOURCES:

1. **Chevrolet Electrical Troubleshooting Manual,** 1982, pp. 8A-118 - 8A-119.

TEACHING ACTIVITIES:

1. Discuss rules to follow when working with electrical components.
2. Explain the operation of various power door locks.
3. Have student(s) read **Chevrolet Electrical Troubleshooting Manual,** 1982, pp. 8A-118-8A-119.
4. Demonstrate how to check and replace lock relay.
5. Demonstrate how to R and R door lock motor.

PERFORMANCE OBJECTIVE 172

CRITERION-REFERENCED MEASURE:

Questions:

1. First always check the ___________ for circuit being worked on.
2. Check voltage at door lock ___________ in the circuit.
3. If only one lock fails to work check the ___________ at the faulty lock.

Answers:

1. Fuse
2. Relay
3. Continuity

Practical Application:

R and R electric door lock components.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 172 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 172 EVALUATION

PERFORMANCE TEST FOR R AND R ELECTRIC DOOR LOCK COMPONENTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Loosened and disconnected battery ground cable.		
2.	Loosened and removed door panel, if required, to gain access to door lock component.		
3.	Disconnected electrical wiring from component.		
4.	Disconnected lock linkage if solenoid is being replaced.		
5.	Loosened and removed any brackets or braces supporting component.		
6.	Loosened and removed component attaching screws.		
7.	Removed component and installed new component in original position.		
8.	Reinstalled and tightened mounting bolts or screws.		
9.	Reinstalled supporting braces or brackets.		
10.	Reinstalled lock linkage if solenoid is being replaced.		
11.	Reconnected and tightened electrical connections.		
12.	Reconnected battery cable.		
13.	Operated lock circuits to verify correct operation from both individual and master control.		
14.	Reinstalled door panel if removed.		

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 173

TASK: Test electric clock.

STANDARD OF PERFORMANCE OF TASK:

All malfunctions of electric clock must be detected and causes determined.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit.

ENABLING OBJECTIVES:

1. Read and interpret service manual.
2. Use tool in standard tool kit.

RESOURCES:

1. **Cadillac Shop Manual,** 1976, pp. 12-73.

TEACHING ACTIVITIES:

1. Discuss safety rules to follow when working with electrical components.
2. Draw and discuss electrical diagram of a clock system.
3. Demonstrate how to test a clock system using a test light.
4. Have student(s) read **Cadillac Shop Manual,** 1976, pp. 12-73 to locate and gain access to the clock.
5. Discuss cautions for not damaging the clock on removal.

PERFORMANCE OBJECTIVE 173

CRITERION-REFERENCED MEASURE:

Questions:

1. Always disconnect the ___________ before working on electrical components.
2. The first check point is always the clock ___________.
3. Check clock feed wire with a ___________ light.

Answers:

1. Battery
2. Fuse
3. Test

Practical Application:

Test electric clock for malfunction.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 173 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 173 EVALUATION

PERFORMANCE TEST FOR TESTING ELECTRIC CLOCK FOR MALFUNCTION

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to fuse panel and checked continuity of clock fuse.	________	________
2. Located and gained access to wiring at back of clock if fuse is not the cause of malfunction.	________	________
3. Loosened and disconnected clock power feed wire.	________	________
4. Attached test light lead to ground at dash.	________	________
5. Probed clock feed wire with test light.	________	________
6. Repaired clock if test light comes on.	________	________
7. Performed clock circuit wiring check if light shows no power in clock feed wire.	________	________

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 174

TASK: R and R electric clock.

STANDARD OF PERFORMANCE OF TASK:

New clock must operate quietly without unusual noises and must maintain accurate time.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Electric clock.

ENABLING OBJECTIVES:

1. Use tools in standard tool kit.
2. Read and interpret shop manual.

RESOURCES:

1. **Chevrolet Electrical Troubleshooting Manual,** 1982, pp. 8A.55, 8A.57.

TEACHING ACTIVITIES:

1. Discuss rules to follow when working with electrical components.
2. Discuss operation of electrical clock.
3. Have student read **Chevrolet Electrical Troubleshooting Manual,** 1982, pp. 8A.55, 8A.57 or R and R procedure of a clock.
4. Demonstrate how to R and R a clock.
5. Explain the procedure for keeping the inside of the automobile clean.

PERFORMANCE OBJECTIVE 174

CRITERION-REFERENCED MEASURE:

Questions:

1. Always disconnect the ____________ before working on electrical component.
2. The ____________ panel sometimes has to be removed to gain access to the clock.
3. Remove the ____________ connection at the clock.

Answers:

1. Battery
2. Dash
3. Electrical

Practical Application:

R and R electric clock.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 174 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 174 EVALUATION

PERFORMANCE TEST FOR R AND R ELECTRIC CLOCK

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Located and gained access to clock.	______	______
2. Loosened and removed trim panels around clock as necessary for removal.	______	______
3. Loosened and removed clock mounting screws.	______	______
4. Loosened and removed electrical connections at clock.	______	______
5. Removed clock from vehicle.	______	______
6. Installed new clock in original position.	______	______
7. Reattached electrical connections.	______	______
8. Reinstalled clock mounting screws.	______	______
9. Verified clock operation.	______	______
10. Reinstalled trim panels and all other parts previously removed to gain access to clock.	______	______

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

DUTY: MAINTAINING AND REPAIRING AUTOMOBILE ELECTRICAL ACCESSORIES

PERFORMANCE OBJECTIVE 175

TASK: Identify source of radio interference.

STANDARD OF PERFORMANCE OF TASK:

Causes of radio interference and repair procedures must be identified.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Radio suppression devices
Test antenna
Manufacturer's diagnosis manual.

ENABLING OBJECTIVES:

1. Use tools for a standard tool kit.
2. Read and interpret manufacturer's shop manual.

RESOURCES:

1. **Cadillac Shop Manual,** 1975, pp. 12.50 - 12.51.

TEACHING ACTIVITIES:

1. Discuss rules to follow when working with electrical components.
2. Explain how a radio works.
3. Discuss different components of an automobile which causes interference in radio.
4. Demonstrate how a radio suppression device works.
5. Explain how to check radio suppressions.

PERFORMANCE OBJECTIVE 175

CRITERION-REFERENCED MEASURE:

Questions:

1. Various types of ignition suppressors are used to prevent ignition ___________ from interfering with radio reception.
2. Make certain ___________ spark plugs are being used to minimize noise.
3. A ___________ is mounted inside of the H.E.I. unit to minimize noise.

Answers:

1. Noise
2. Resistance
3. Capacitor

Practical Application:

Identify cause of radio interference.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 175 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 175 EVALUATION

PERFORMANCE TEST FOR IDENTIFYING CAUSE OF RADIO INTERFERENCE

Student's Name **Date**

DIRECTIONS TO STUDENT:	Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.
DIRECTIONS TO EVALUATOR:	Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Operated radio at moderate volume with both engine off and engine on, on a weak AM station to identify if interference is coming from engine or antenna system.	______	______
2. Substituted a test antenna to determine if radio interference is from malfunctioning antenna or malfunctioning radio components.	______	______
3. Operated engine with alternator belt removed to determine if interference is from alternator or ignition system.	______	______
4. Repaired alternator if it is at fault.	______	______
5. Performed ignition system diagnosis if it is determined to be at fault.	______	______
6. Repaired or replaced antenna or lead-in if it is determined to be at fault.	______	______
7. Repaired or replaced radio if it is determined to be at fault.	______	______
8. Referred to manufacturer's suggestions for additional noise suppression components if problem can not be corrected by repairs listed above.	______	______
9. Noted results on work order.	______	______

APPROVED: Yes _____ No ______

Evaluator's Signature **Date**

CONDUCTING SHOP OPERATIONS

DUTY: CONDUCTING SHOP OPERATIONS

PERFORMANCE OBJECTIVE 176

TASK: Estimate time and cost for a job.

STANDARD OF PERFORMANCE OF TASK:

All elements of the job must have been identified and correctly looked up in Labor Time Guide, and all parts must be identified and costed without error.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Labor Time Guide
Parts manual
Job cost form.

ENABLING OBJECTIVES:

1. Read and interpret labor guide.
2. Read and interpret parts manual.

RESOURCES:

1. **Mitchell Parts and Labor Guide.** p. G3.

TEACHING ACTIVITIES:

1. Explain how to write an estimate using a parts and labor guide.
2. Discuss contents and index page of a section in manual.
3. Explain the skill level for each job.
4. Discuss hourly rate conversion table.
5. Demonstrate how to estimate the cost of a job using a parts and labor guide.

PERFORMANCE OBJECTIVE 176

CRITERION-REFERENCED MEASURE:

Questions:

1. When two part numbers are listed together the first number is the ___________ and the second number is ___________ hand part.
2. The labor ___________ table allows you to convert hours to dollars.
3. The hourly rate is listed in ___________ of an hour.

Answers:

1. Right, left
2. Conversion
3. Tenths

Practical Application:

Estimate time and cost for a job using the labor guide.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 176 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 176 EVALUATION

PERFORMANCE TEST FOR ESTIMATING TIME AND COST FOR A JOB USING THE LABOR GUIDE

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1.	Listed all tasks or elements of the job which must be done.	______	______
2.	Looked up all tasks in the Labor Time Guide.	______	______
3.	Added up the total time required and multiplied by the standard hourly rate for the shop.	______	______
4.	Listed all parts required (including fluids) and looked up part numbers.	______	______
5.	Looked up costs for each part and obtained total for entire job.	______	______
6.	Added parts and labor costs to obtain total cost.	______	______
7.	Rechecked steps 1 through 6.	______	______

APPROVED: Yes ______ No ______

Evaluator's Signature **Date**

DUTY: CONDUCTING SHOP OPERATIONS

PERFORMANCE OBJECTIVE 177

TASK: Complete work order form.

STANDARD OF PERFORMANCE OF TASK:

All required information must be recorded on work order form without error.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Work order form.

ENABLING OBJECTIVES:

1. Read and interpret a labor and parts guide.
2. Recognize and use a work order form.

RESOURCES:

1. **Mitchell Parts and Labor Guide,** 1981, p. G-3.

TEACHING ACTIVITIES:

1. Discuss the information needed from a customer work order.
2. Discuss how to diagnose a problem with the help of a customer.
3. Demonstrate how to write a work order.
4. Explain why a customer's signature is needed on a work order.
5. Have students act out the part of a customer with an automobile to be repaired.

PERFORMANCE OBJECTIVE 177

CRITERION-REFERENCED MEASURE:

Questions:

1. Using a ___________ guide you can estimate the time of a job.
2. The customer's ____________ authorizes the work to be done.
3. Vehicle data includes make, model, year and ___________ number plus odometer reading.

Answers:

1. Labor
2. Signature
3. Identification

Practical Application:

Compile information on work order.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 177 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 177 EVALUATION

PERFORMANCE TEST FOR COMPILING INFORMATION ON WORK ORDER

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

	ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1.	Discussed work needed with customer; made diagnosis if necessary.	________	________
2.	Filled in customer's name, address and telephone number.	________	________
3.	Filled in vehicle data including make, model, year, identification number.	________	________
4.	Wrote in a description of the work to be done.	________	________
5.	Obtained customer's signature authorizing work.	________	________
6.	Estimated time when job will be completed.	________	________
7.	Estimated cost if necessary.	________	________
8.	Placed work order form in rack of jobs to be done.	________	________

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: CONDUCTING SHOP OPERATIONS

PERFORMANCE OBJECTIVE 178

TASK: Update service manual file.

STANDARD OF PERFORMANCE OF TASK:

All new pages or pen and ink changes must be entered in their correct locations without error.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Service Manual and new pages and/or description of changes to be made.

ENABLING OBJECTIVES:

1. Read and interpret service manual.
2. Recognize update sheets.

RESOURCES:

1. **Mitchell Manual Tune Up I.** p. 2.

TEACHING ACTIVITIES:

1. Explain reason for having to add pages to a manual.
2. Demonstrate how to disassemble a manual.
3. Have student(s) read **Mitchell Manual Tune Up I,** page 2 on how to put in new material.
4. Demonstrate how and where pen and ink changes are to be made.
5. Demonstrate how to destroy old pages.

PERFORMANCE OBJECTIVE 178

CRITERION-REFERENCED MEASURE:

Questions:

1. The old page must first be ___________ from the manual.
2. Insert ___________ pages in place of old pages.
3. Make changes only on ___________ pages as instructed.

Answers:

1. Removed
2. New
3. Old

Practical Application:

Update service manual files.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 178 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 178 EVALUATION

PERFORMANCE TEST FOR UPDATING SERVICE MANUAL FILES

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	**Satisfactory**	**Unsatisfactory**
1. Examined all new pages or changes.	____	____
2. Inserted new pages, one at a time, in place of the old pages.	____	____
3. Made pen and ink changes on existing pages as required.	____	____
4. Destroyed old pages which were replaced.	____	____

APPROVED: Yes _____ No _____

Evaluator's Signature Date

DUTY: CONDUCTING SHOP OPERATIONS

PERFORMANCE OBJECTIVE 179

TASK: Schedule customer appointments.

STANDARD OF PERFORMANCE OF TASK:

Job must be scheduled with a minimum of lost shop time and a minimum wait for the customer.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Flat Rate Manual.

ENABLING OBJECTIVES:

1. Read and interpret Flat Rate Manual.
2. Select and use scheduling sheets.

RESOURCES:

1. **Mitchell Part I Labor Guide,** 1981.

TEACHING ACTIVITIES:

1. Explain customer relations.
2. Demonstrate how to look up time required for a job.
3. Demonstrate how to set up jobs for time slots.
4. Discuss scheduling work among other jobs.
5. Demonstrate how to fill out a scheduling sheet.

PERFORMANCE OBJECTIVE 179

CRITERION-REFERENCED MEASURE:

Questions:

1. A __________ __________ manual is used to estimate time required for a job.
2. If parts are not available they must be __________.
3. Estimate work hours available when setting up __________ to be performed.

Answers:

1. Flat Rate
2. Ordered
3. Jobs

Practical Application:

Scheduling customer appointments.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 179 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 179 EVALUATION

PERFORMANCE TEST FOR SCHEDULING CUSTOMER APPOINTMENTS

Student's Name **Date**

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Estimated or used flat rate manual to determine amount of time required for the job.	______	______
2. Determined whether parts are available or must be ordered.	______	______
3. Examined schedule of other jobs to be performed.	______	______
4. Estimated work hours available in light of other jobs.	______	______
5. Determined when job to be scheduled can be fit in among other jobs.	______	______
6. Marked in job on scheduling form.	______	______

APPROVED: Yes _____ No _____

Evaluator's Signature **Date**

DUTY: CONDUCTING SHOP OPERATIONS

PERFORMANCE OBJECTIVE 180

TASK: Schedule outside shop work.

STANDARD OF PERFORMANCE OF TASK:

Job must be delivered to and received from specialty shop as scheduled.

SOURCE OF STANDARD:

Writing Team, State of Pennsylvania.

CONDITIONS FOR PERFORMANCE OF TASK:

Telephone.

ENABLING OBJECTIVES:

1. Select and use outside work scheduling forms.
2. Read and interpret a flat manual.

RESOURCES:

1. **Mitchell Flat Rate Manual 1984.**

TEACHING ACTIVITIES:

1. Discuss how to use manual to determine work hours to complete jobs.
2. Explain where to find outside shops.
3. Demonstrate how to set up outside work.
4. Explain how to use the telephone to set up outside work.
5. Demonstrate how to set up a schedule for delivery of workpiece.

PERFORMANCE OBJECTIVE 180

CRITERION-REFERENCED MEASURE:

Questions:

1. When scheduling outside work always get an estimate of cost and ___________.
2. Always telephone customer to determine if work schedule is ___________.
3. You should make arrangements to ___________ workpiece to specialty shop.

Answers:

1. Time
2. Satisfactory
3. Deliver

Practical Application:

Schedule outside shop work.

Method of Evaluating Practical Application:

Use Checklist Performance Objective 180 to determine if the assignment was completed with 100 percent accuracy.

CHECKLIST FOR PERFORMANCE OBJECTIVE 180 EVALUATION

PERFORMANCE TEST FOR SCHEDULING OUTSIDE SHOP WORK

Student's Name Date

DIRECTIONS TO STUDENT: Set-up the proper equipment. Follow the verbal directions given by the instructor. Complete each step in the sequential order listed.

DIRECTIONS TO EVALUATOR: Observe the student. Pay close attention to items to be evaluated. Be sure the student completes the tasks within a reasonable time. A score of 100 percent is required for competency.

ITEMS TO BE EVALUATED	Satisfactory	Unsatisfactory
1. Examined workpiece requiring outside shop work.		
2. Telephoned shop and described work required; received estimated time of completion.		
3. Telephoned customer and determined whether schedule is satisfactory or if another alternative is preferred.		
4. Telephoned specialty shop and confirmed schedule; delivered workpiece.		

APPROVED: Yes _____ No ______

Evaluator's Signature Date

APPENDICES

APPENDIX A

CROSS-REFERENCE TABLE OF DUTIES, TASKS, AND PERFORMANCE OBJECTIVES

APPENDIX A

CROSS-REFERENCE TABLE OF DUTIES, TASKS, AND PERFORMANCE OBJECTIVES

The purpose of this table is to cross-reference changes made since compiling the original task inventory and completing the survey of the incumbent workers. The information contained in the cross-reference table is described below:

1. * Indicates a performance objective was not written due to recommendations from the Writing Team and/or Field Review Team.

2. ** Indicates a write in task to catalog by incumbents during development of catalog. Since these tasks did not appear on the occupational inventory, there is no survey data available on them.

3. Task statements listed below the numbered task statements and enclosed in parenthesis reflect the wording of the original statement as it appeared on the occupational inventory.

   Example: Fabricate fiberglass duct
   (Fabricate fiberglass elbow).

   These changes were made by the Field Review Team in order to further clarify the performance objective.

4. Task number in parenthesis which precedes the task statement indicates that a task has been subsumed or sub divided.

CROSS REFERENCE TABLE OF DUTIES AND TASKS

	DUTY/TASK	TASK/PAGE NUMBER	PERCENT PERFORMING
A.	Auto Heating, Cooling, and Air Conditioning System Diagnosis		
01	Identify causes of engine overheating.	1/5	78.9
02	Inspect cooling system components for leaks.	2/8	78.9
03	Identify the source of unusual operating noises.	3/11	73.7
04	Test the air conditioning system for specified output.	4/14	78.9
05	Test air conditioner charge.	5/17	78.9
06	Test the air conditioning system for freon and oil leaks.	6/20	82.5
07	Inspect belts and pulleys.	7/23	84.2
08	Inspect refrigeration components and hoses for restrictions.	8/26	71.9
09	Inspect air conditioning condenser for air flow restrictions.	9/29	75.4
10	Inspect control cable operation.	10/32	77.2
11	Identify causes of heater temperature control problems.	11/35	78.9
12.	Inspect operation of air control doors.	12/38	71.9
13.	Inspect air conditioner clutch assembly.	13/42	73.7
14.	Inspect heater hoses for condition and leaks.	14/45	78.9
15.	Inspect blower motor operation.	15/48	78.9
16.	Check heater water control valve operation.	16/51	80.7

		DUTY/TASK	TASK/PAGE NUMBER	PERCENT PERFORMING
B.		Maintaining and Repairing Automobile Air Conditioning Systems		
	01	Test vacuum components.	17/55	80.7
	02	R & R vacuum motor. (R & R vacuum components.)	20/64	77.2
	03	Test clutch thermostatic switch.	21/67	75.4
	04	R & R clutch thermostatic switch.	22/70	71.9
	05	R & R magnetic clutch assembly.	23/73	75.4
	06	Charge system.	54/170	82.5
	07	R & R refrigerant lines.	18/58	82.5
	08	Fabricate refrigerant lines.	19/61	56.1
	09	R & R compressor seals.	24/76	73.7
	10	Check compressor oil level.	25/79	70.2
	11	R & R dryer.	26/82	78.9
	12	R & R condenser.	27/85	78.9
	13	R & R evaporator.	28/88	77.2
	14	R & R expansion tube.	29/91	77.2
	15	R & R measured orifice valve/ expansion valve.	30/94	75.4
	16	Test suction throttling valve.	31/97	61.4
	17	R & R suction throttling valve.	32/100	61.4
	18	R & R compressor.	33/103	80.7
	19	Install air conditioner system.	34/107	45.6
	20	R & R low pressure cutout switch.	35/111	75.4

	DUTY/TASK	TASK/PAGE NUMBER	PERCENT PERFORMING
21	R & R high pressure cutout switch.	36/114	73.7
22	R & R drive or idler pulleys.	37/117	78.9
23	R & R compressor clutch bearing.	38/120	75.4
24	Add oil to compressor.	39/124	78.7
25	R & R compressor reed valve assembly.	40/128	54.4
26	R & R muffler hose assembly.	41/131	68.4
27	R & R hose seals.	42/134	75.4
28	Clean and straighten condenser fins.	43/137	66.7
29	Test expansion valve.	44/140	71.9
30	R & R expansion valve and inlet screen.	45/143	75.4
31	Inspect evaporator housing water drain.	46/146	77.2
32	Repair evaporator housing water drain.	47/149	73.7
33	R & R evaporator pressure control valve.	48/152	66.7
34	R & R evaporator temperature control valve/sensor.	49/155	66.7
35	R & R system service valves.	50/158	70.2
36	R & R high pressure relief valve.	51/161	63.2
37	R & R POA valve.	52/164	68.4
38	R & R VIR valve.	53/167	64.9
C.	Maintaining and Repairing Automobile Cooling and Heating Systems		
01	R & R water control valve.	55/174	80.7
02	Test thermostat.	56/177	78.9
03	R & R thermostat.	57/180	82.5

	DUTY/TASK	TASK/PAGE NUMBER	PERCENT PERFORMING
04	R & R heater core. (inside access)	58/183	80.7
05	R & R heater core. (outside access)	59/186	82.5
06	R & R hoses.	60/189	82.5
07	Test thermal sensing switch.	61/192	71.9
08	R & R thermal sensing switch.	62/195	73.7
09	R & R drive belts.	63/198	80.7
10	Test antifreeze.	64/201	82.5
11	Clean cooling system chemically.	65/204	61.4
12	Check variable speed fan clutch.	66/207	75.4
13	R & R variable speed fan clutch.	67/210	77.2
14	R & R electric cooling fan motor.	68/213	80.7
15	Test radiator pressure cap.	69/216	80.7
16	Pressure test cooling system.	70/219	80.7
17	R & R radiator.	71/222	82.5
18	Inspect water pump.	72/225	82.5
19	R & R water pump.	73/228	82.5
20	R & R freeze plugs.	74/231	77.4
21	Test cold lockout switch.	75/234	42.1
22	R & R cold lockout switch.	76/237	42.1
D.	Maintaining and Repairing Air Conditioning and Heating Control Units		
01	R & R electrical control switches.	77/241	77.4
02	Test relays.	78/244	82.5
03	R & R relays.	79/247	86.0

	DUTY/TASK	TASK/PAGE NUMBER	PERCENT PERFORMING
04	Test blower motor resistors.	80/250	82.5
05	R & R blower motor resistors.	81/253	84.2
06	(E1) Test connectors and wires of electrical circuits.	82/256	86.0
07	R & R connectors and wires of electrical circuits.	83/259	86.0
08	Adjust air conditioning and heater control cables.	84/262	82.5
09	R & R air conditioning and heater control cables.	85/265	82.5
10	R & R ducts and outlets.	86/268	78.9
11	Test vacuum pumps.	87/271	57.9
12	R & R vacuum pumps.	88/274	56.1
E.	Diagnosing the Automobile Electrical System		
01	(D7) Test continuity of electrical circuits.	------	93.0
02	Measure voltages in electrical circuits.	89/278	94.7
03	Test for shorts and grounds.	90/281	96.5
04	Inspect fusible links, circuit breakers and fuses.	91/285	96.5
05	Inspect battery electrolyte.	92/288	87.7
06	Test specific gravity of battery electrolyte.	93/291	87.7
07	Load test the battery(s).	94/294	93.0
08	Test starter current draw.	95/297	89.5
09	Test starter circuit voltage drop.	96/300	86.0
10	Check components and wires in starter control circuit.	97/303	89.5

	DUTY/TASK	TASK/PAGE NUMBER	PERCENT PERFORMING
11	Identify problems that cause dash indicator to show no charge.	98/307	93.0
12	Test alternator output.	99/310	91.2
13	Test voltage regulator.	100/313	91.2
14	Identify cause of lamp failure.	101/316	89.5
15	Identify turn signal and hazard light malfunction.	102/319	87.7
16	Identify cause of incorrect fuel and temperature gauge readings.	103/322	91.5
17	Identify the cause of horn malfunctions.	104/325	87.7
18	Identify the cause of windshield wiper/washer malfunction.	105/328	89.5
F.	Maintaining and Repairing Basic Automotive Electrical System.		
01	Clean battery, posts, and cable connections.	115/361	93.0
02	R & R battery.	116/364	91.2
03	R & R battery cables.	117/367	93.0
04	Charge battery.	118/370	93.0
05	R & R alternator.	119/373	93.0
06	R & R alternator bearings.	114/357	82.5
07	R & R alternator brushes.	106/332	86.0
08	Test alternator diodes and rectifier bridge.	107/335	82.5
09	R & R alternator diodes.	108/338	78.9
10	Test alternator rotor.	109/342	78.9

	DUTY/TASK	TASK/PAGE NUMBER	PERCENT PERFORMING
11	R & R alternator rotor.	110/345	80.7
12	Test alternator stator.	111/348	78.9
13	R & R alternator stator.	112/351	80.7
14	Adjust voltage regulator output.	113/354	61.4
15	R & R voltage regulator.	122/383	87.7
16	Inspect starter drive gear.	123/387	89.5
17	R & R starter.	124/390	91.2
18	R & R starter drive.	120/377	89.5
19	R & R starter relay and/or solenoid.	121/380	91.2
20	R & R starter brushes.	125/393	78.9
21	R & R starter bushings.	126/397	75.4
22	Test starter armature.	127/401	78.9
23	R & R starter armature.	128/404	73.7
24	Test field circuits.	129/407	77.2
25	Test solenoid.	130/410	89.5
26	R & R field circuits.	131/414	89.5
27	Test switches.	132/418	93.0
28	Test fuses.	133/421	94.7
29	R & R fuses.	134/424	94.7
30	Test circuit breakers.	135/427	94.7
31	Inspect lighting system for faulty bulbs.	137/433	89.5
32	R & R fuse block assembly.	136/430	82.5

DUTY/TASK		TASK/PAGE NUMBER	PERCENT PERFORMING
33	R & R light bulbs.	138/436	89.5
34	R & R sockets.	139/439	89.5
35	Adjust headlights.	140/442	82.5
36	R & R dimmer switch.	141/445	87.7
37	R & R turn signal switch.	142/448	89.5
38	Adjust backup light switch.	143/451	77.2
39	R & R backup light switch.	144/454	87.7
40	Adjust stop light switch.	145/457	87.7
41	R & R horn relay.	146/460	87.7
42	R & R horn.	147/463	89.5
43	R & R windshield wiper motor.	148/466	89.5
44	R & R windshield washer motor.	149/469	87.7
45	Test instrument gauges.	150/472	78.7
46	R & R instrument gauges.	151/475	89.5
47	Test sending units.	152/478	89.5
48	R & R sending units.	153/481	89.5
49	Test warning lamps.	154/484	86.0
50	R & R warning lamps.	155/487	87.7
G.	Maintaining and Repairing Automobile Electrical Accessories		
01	Test cruise control servo.	156/491	73.7
02	Adjust cruise control system.	157/494	66.7
03	R & R cruise control components.	158/498	75.4

		DUTY/TASK	TASK/PAGE NUMBER	PERCENT PERFORMING
	04	Test automatic alarm system.	159/501	40.4
	05	R & R automatic alarm system components.	160/504	38.6
	06	Inspect radio speaker.	161/507	70.2
	07	R & R radio speaker.	162/510	70.2
	08	Test radio antenna.	163/513	66.7
	09	R & R radio antenna.	164/516	73.7
	10	Trim radio antenna.	165/520	64.9
	11	R & R power antenna motor.	166/523	73.7
	12	R & R power window motor.	167/526	77.2
	13	R & R power seat components (switches, motors, and transmission)	168/529	71.9
	14	R & R cigarette lighter receptacle.	169/532	87.7
	15	Test rear defogger.	170/535	82.5
	16	R & R rear defogger components.	171/538	80.7
	17	R & R electric door lock components	172/541	77.2
	18	Test electric clock.	173/544	68.4
	19	R & R electric clock.	174/547	73.7
	20	Identify source of radio interference.	175/550	63.2
H.	Conducting Shop Operations			
	01	Estimate time and cost for a job.	176/554	
	02	Complete work order form.	177/557	
	03	Update service manual file.	178/560	
	04	Schedule customer appointments.	179/563	
	05	Schedule outside shop work.	180/566	

APPENDIX B

DEFINITION OF TERMS

APPENDIX B

DEFINITION OF TERMS

A number of terms frequently used in this guide may be unfamiliar to the reader; others may be familiar, but in the context of this handbook have been assigned special meanings.

AFFECTIVE.
Skills which emphasize an attitude, feeling, emotion, or degree of acceptance and rejection.

CATALOG.
A comprehensive collection of performance objectives, performance guides, and related data developed in a specific domain.

CBVE (COMPETENCY-BASED VOCATIONAL EDUCATION).
A methodology of instruction that (a) identifies the abilities and skills needed for on-the-job performance; (b) informs students and teachers of the precise and detailed learning objectives required to achieve these competencies; (c) emphasizes performance standards in testing, course requirements, and/or graduation; and (d) facilitates learning by letting each student master the tasks prior to advancing to another.

CHECKPOINT.
A point in the development of the V-TECS product when material must be sent to V-TECS central office for quality review.

CIP (CLASSIFICATION OF INSTRUCTION PROGRAM) CODE.
A code developed by the U.S. Office of Education to identify a specific cluster of related jobs for training program identification.

COGNITIVE.
Skills which emphasize the recall of knowledge and development of intellectual abilities.

COMPETENCY.
The ability (including knowledge, skills, and/or attitudes) to perform a specific task or duty successfully.

CONDITIONS.
Describes the situation for competent task performance, including tools and equipment to be used, and limitations under which the tasks will be performed.

CONSORTIUM.
A group of state agencies, institutions, or other entities which have been legally constituted through letters of commitment, agreements, or by assignment of higher authorities to work together toward the solution of problems in education. A consortium, for the purposes of this work, must have membership from autonomous agencies and institutions which cut across state boundaries as they attempt to solve problems or meet goals.

CRITERION-REFERENCED MEASURES.
An evaluative procedure used to determine if a student has mastered a performance objective.

CROSS-REFERENCE TABLE.
A table that identifies the relationship among duties and tasks found in the occupational inventory and the performance objectives in the final catalog. Also noted are percentages of incumbents performing the tasks by D.O.T.

CURRICULUM GUIDE.
An instructional resource developed from a V-TECS catalog to guide CBVE for an occupation.

DICTIONARY OF OCCUPATIONAL TITLES (D.O.T.).
A document published by the U.S. Department of Labor, Employment and Training Administration. This publication groups occupations into systematic occupational classification structures based on interrelationships of job tasks and requirements.

DISTRACTOR.
An incorrect response to a multiple-choice or true/false test item.

DOMAIN (OCCUPATIONAL DOMAIN).
A group of job titles that are related on the basis of required skills and knowledge.

D.O.T. CODE.
A nine-digit number used to identify a specific job within a given calendar year.

DUTY.
A cluster of related tasks performed by incumbent workers in an occupational domain.

ENABLING OBJECTIVE.
An objective related to background knowledge or skills that are prerequisite to the mastery of a given task.

FIELD TEST.
The process of using and refining drafts of V-TECS materials for the purpose of identifying content errors or technical problems.

GUIDE SHEET.
Instructional information including the duty, performance objective, task, performance of standard, survey of standard, conditions for performance of tasks, enabling objectives, resources, teaching activities, criterion-reference measures, and performance guide.

JOB.
A group of tasks performed by a job incumbent.

JOB INCUMBENT.
An individual who is currently employed in an occupation.

OCCUPATIONAL ANALYSIS (Task Analysis).
The process of reviewing elements of a job for the purpose of improving training program content across program levels of vocational-technical education.

OCCUPATIONAL INVENTORY(Task Inventory Booklet).
A survey instrument listing tasks performed and tools and equipment used by job incumbents in an occupational domain.

OCCUPATIONAL SURVEY.
The procedures for collecting data to identify the duties and tasks that comprise one or more jobs, job types, or career field ladders for the collection and analysis of information concerning such duties.

O.E./CIP CODE.
A code developed by the U.S. Office of Education to identify a specific cluster of related jobs for training program identification.

PERFORMANCE-BASED INSTRUCTION.
Instruction which required the learners demonstration of specific competencies. The desired abilities are selected before the instruction is described and are clearly defined as observable performance objectives.

PERFORMANCE CHECKLIST.
A list of performance steps derived from the performance guide to record acceptable or unacceptable performance of each step of a task.

PERFORMANCE GUIDE (PG).
A series of steps required for performance of a task arranged in the sequence ordinarily followed.

PERFORMANCE OBJECTIVE (PO).
A statement, in precise measurable terms, of a particular behavior to be exhibited by a learner under specified conditions, including a standard of performance.

PSYCHOMOTOR.
Skills which emphasize manipulation of material or tools.

QUALITY REVIEW.
A review of content by V-TECS staff or designated representative to examine quality of content, format, and style of V-TECS product(s).

RESOURCES.
Materials which are used to develop instruction and/or learner-specific objectives.

SOURCE OF STANDARD.
A person or origin from which the information establishing the standard is received.

STANDARD.
The criteria used to determine if a task has been successfully or unsuccessfully performed.

STATE-OF-THE-ART REFERENCE.
Current materials from which information or resources can be found to facilitate instruction.

STATE-OF-THE-ART (SOA) STUDY.
Research conducted to determine the current status of performance-based instructional materials and practices in the domain area under study and to obtain other information that might be useful in catalog development.

SUBJECT-MATTER EXPERT.
A highly experienced person (job incumbent instructor) who assists in identifying task performance steps, skills, and knowledge necessary to perform the job.

TASK.
A unit of work activity which constitutes logical and necessary steps in the performance of a duty. A task has a definite beginning and ending point in its accomplishments and generally consists of two or more definite steps.

TASK ANALYSIS.
The process of reviewing elements of a job for the purpose of improving training program content across program levels of vocational technical education.

TASK CRITICALITY.
That aspect of a task statement which makes its accomplishment crucial to the acceptable performance of a worker or student.

TASK LIST.
A list of tasks performed by incumbents in a specific occupation domain.

TEACHING ACTIVITIES.
Methods and/or procedures for delivering instructional content to students.

TEST-ITEM BANK.
A collection of criterion-referenced test items coded for input and retrieval by computer or manual methods.

VALIDATION.
The process of assuring that all aspects of an occupational task analysis identifies the skills, knowledge, and attitudes performed in the occupation.

VERIFICATION.
The procedure of collecting data to substantiate an existing product; for example, task list verification.

V-TECS.
An acronym representing: Vocational-Technical Education Consortium of States; 1866 Southern Lane, Decatur, GA 30033-4097.

V-TECS CATALOG.
An incumbent-based description of the duties, tasks, performance objectives, performance guides, and related data in a specified occupation.

WORKING CONDITIONS.

The atmospheric and environmental conditions under which a worker performs a specific job.

WRITING TEAM.

A team of people representing instructors with subject matter expertise; persons having knowledge and experience in developing criterion-referenced measures; local or state supervisors in the domain being developed; workers and supervisors of incumbent workers whose function is to analyze occupational data and develop performance objectives for specific D.O.T. areas.

APPENDIX C

TOOLS/EQUIPMENT/WORK AIDS

APPENDIX C

TOOLS/EQUIPMENT/WORK AIDS BY PERCENTAGE OF INCUMBENTS USING

Equipment Number	Equipment Description	Percentage Using	Number Using
16	Creeper	100.0	57
22	Drill, set	100.0	57
24	Drop light	100.0	57
32	Hammer, ball peen	100.0	57
39	Jack, floor	100.0	57
60	Pliers, needle nose	100.0	57
95	Wire stripper and crimper	100.0	57
103	Wrench, vise grip	100.0	57
21	Drill, electric, 3/8"	98.2	56
31	Hacksaw	98.2	56
55	Pliers, diagonal cutting	98.2	56
58	Pliers, lock ring	98.2	56
62	Pry bar	98.2	56
65	Puller, gear and pulley	98.2	56
74	Screwdriver set, phillips	98.2	56
75	Snap ring tool	98.2	56
99	Wrench set, combination, 3/8"--1 1/4"	98.2	56
102	Wrench set, open end, 3/8"--1 1/4"	98.2	56
45	Magnetic pick-up tool	96.5	55
66	Puller, seal	96.5	55
73	Screwdriver set, blade tip	96.5	55
78	Socket set, 3/8" drive, 1/4--15/15"	96.5	55
98	Wrench set, combination, 3/8"--1 1/4"	96.5	55
101	Wrench set, metric	96.5	55
10	Cables, booster	94.7	54
12	Charger, battery	94.7	54
28	Flashlight, general purpose	94.7	54
30	Goggles, safety	94.7	54
59	Pliers, long nose	94.7	54
68	Punch and Chisel set	94.7	54
76	Socket set, 1/4" drive, 1/8--9/16"	94.7	54
83	Test leads	94.7	54
94	Volt ohmmeter	94.7	54
97	Wrench set, Allen, USS	94.7	54
77	Socket set, 1/4" drive, 1/8--9/16"	93.0	53
89	Tool, battery terminal	93.0	53
3	Analyzer, battery	91.2	52
4	Analyzer, charging system	91.2	52
25	File set, assorted	91.2	52

Equipment Number	Equipment Description	Percentage Using	Number Using
53	Pliers, battery	91.2	52
79	Stands, safety	91.2	52
86	Tester, circuit	91.2	52
5	Analyzer, starting charging system	89.5	51
23	Drop cord	89.5	51
40	Knife, mechanics	89.5	51
57	Pliers, hose clamp	89.5	51
72	Screwdriver, offset, phillips	89.5	51
82	Tap set, rethreading, USS	89.5	51
84	Tester, anti-freeze	89.5	51
46	Mallet, rubber	87.7	50
49	Nut driver set, SAE	87.7	50
71	Screw extractor set	87.7	50
85	Tester, battery cell	87.7	50
17	Cutter, tubing	86.0	49
61	Pliers, slip joint	86.0	49
63	Puller, battery terminal	86.0	49
36	Indicator, starter current	84.2	48
52	Pliers, angle nose	84.2	48
56	Pliers, end cutting	84.2	48
27	Flaring tool, tubing	82.5	47
33	Hammer, plastic	82.5	47
35	Indicator, alternator current	82.5	47
44	Machinist's rule, 6"	82.5	47
87	Tester, pressure	82.5	47
92	Vacuum pump, air-conditioning	82.5	47
81	Tap set, rethreading, metric	78.9	45
88	Thermometer, 0° -- 220°	78.9	45
43	Lifter, battery	77.2	44
54	Pliers, curved nose	77.2	44
70	Scraper, carbon	77.2	44
100	Wrench set, ignition	77.2	44
8	Brush, wire, assorted	75.4	43
34	Headlamp aiming kit	75.4	43
48	Nut driver set, metric	75.4	43
50	Oilers, assorted	75.4	43
64	Puller, cotter key	75.4	43
67	Puller, slide hammer	75.4	43
96	Wrench, torque, 3/8"	75.4	43
9	Brushing driver set	73.7	42
80	Switch, remote starter	73.7	42
90	Tool kit, air conditioning compressor	73.7	42
93	Valve, refrigerant can	71.9	41
1	Adapter set, air condition valves	70.2	40
2	Air compressor with fittings	70.2	40
13	Charging station, air conditioning	70.2	40
26	Filer, battery	70.2	40
19	Dial indicator set	66.7	38

Equipment Number	Equipment Description	Percentage Using	Number Using
29	Gauge, radiator temperature	66.7	38
41	Leak detector, electronic	66.7	38
47	Micrometer, 0 -- 1"	66.7	38
11	Caliper, vernier	64.9	37
37	Installer, air conditioning valve	64.9	37
6	Armature growler	63.2	36
38	Installer, needle bearing	61.4	35
42	Leak detector, halide	61.4	35
51	O-ring installer	59.6	34
69	Reamer kit	59.6	34
14	Check valve, refrigerant	57.9	33
20	Dip stick set, compressor	56.1	32
91	Tool kit, VIR assembly	50.9	29
15	Cleaning and flushing tool, STA/POA valves	47.4	27
18	Cutter set, gasket	47.4	27
7	Armature turning tool	38.6	22

STANDARD TOOL KIT

A "standard tool kit" was defined by the Writing Team to include the following tools:

Battery Post Cleaner
Bench, Work
Cart, Service
Channel Lock Pliers
Chisel and Punch Set
Diagonal Cutting Pliers
Drop Light
Hammers, Assorted
Measuring Tape
Needle nose Pliers, Assorted
Scratch Awl
Screwdrivers, Philips
Screwdrivers, Slot head
Slip Joint Pliers, Assorted
Vise Grip Pliers
Vise, Machinist
Wrenches, Adjustable, Set
Wrenches, Allen
Wrenches, Box
Wrenches, Open End and Combination Box
Wrenches, Socket Set, 1/4 inch Drive
Wrenches, Socket Set, 3/8 inch Drive
Terminal Kit and Crimping Tool
Putty Knives -- Wide and Narrow
Torque Wrench
Soldering Kit
Test Light with Lead
Electrician's Tape
Mechanics Wire

APPENDIX D

STATE-OF-THE-ART-LITERATURE

APPENDIX D

STATE-OF-THE-ART LITERATURE

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APPENDIX F

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Writing team of incumbent workers from the state of Pennsylvania.